Appendices

City of Chico

Storm Water Master Plan

Appendix A – Municipal Code Revision Recommendations

Appendix A.1 – Storm Water Management and Discharge Controls

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City of Chico

Storm Water Master Plan

Appendix A.1 – Storm Water Management and Discharge Controls

City of Chico Code of Ordinances

Chapter 15.50 – Storm Water Management and Discharge Controls

15.50.010 Intent and purpose.

The purposes of this chapter are:

A. To protect and enhance the water quality of the City's watercourses, water bodies and wetlands pursuant to, and consistent with, the federal Water Pollution Control Act (Clean Water Act) (33 U.S.C. § 1251 et seq.), the Porter-Cologne Water Quality Control Act (Wat. Code § 13000 et seq.), and the ~~City's~~ National Pollutant Discharge Elimination System (NPDES) General P~~p~~ermit and Waste Discharge Requirements (WDRs) for the storm water discharges from the City's municipal storm drain system, as such permit is amended and/or renewed by the California State ~~Regional~~ Water Resources ~~Quality~~ Control Board (~~Regional~~ State Water Board).

B. To protect and promote the health, safety and general welfare of the citizens of the City by prescribing regulations to effectively prohibit non-storm water discharges to the City's storm drain system and to reduce the discharge of pollutants in storm water to the maximum extent practicable ~~by:~~

~~1. Regulating non-storm water discharges to the City's storm drain system;~~

~~2. Controlling the discharge to the City's storm drain system from spills, overland flow, dumping or disposal of materials other than storm water;~~

~~3. Reducing pollutants in storm water discharges from the City's storm drain system to the maximum extent practicable;~~

~~4. Minimizing degradation of the water quality of watercourses and the disruption or pollution of natural or City-authorized drainage flows caused by the activities of clearing and grubbing, grading, filling and excavating of land, as well as sediment and pollutant run off from other construction-related activities; and~~

~~5. Controlling industrial and commercial pollutant discharges to the City's storm drain system.~~

15.50.020 Definitions.

The following words and phrases, when used in this chapter, shall have the following meanings. Words and phrases used in this chapter and not otherwise defined shall be interpreted as defined in the regulations of the United States Environmental Protection Agency to implement the provisions of the federal Clean Water Act and as defined by the ~~California Water Resources Control~~ State Water Board to implement the Porter-Cologne Water Quality Control Act.

A. "Best management practices" or "BMPs" means physical, structural and/or managerial practice that when used singly or in combination, prevent or reduce pollution of storm water.

B. "Construction site" means any project, including projects requiring coverage under the Construction G~~g~~eneral ~~construction p~~Permit, that involves soil disturbing activities including, but not limited to, clearing, grading, paving, disturbances to ground such as stockpiling, and excavation.

Commented [KA1]: It seems that this section of code would be updated to reflect the adopted Statewide Trash Amendments, but that these modifications would be proposed at the same time that the Post Construction Standards Plan were to be updated. Is this something that the City is thinking about doing (updating the Post-Construction Standards)?

If so – there would be additional, proposed edits to this section of code.

Commented [KA2]: Edits proposed to align this with the title of the permit and issuing agency.

Commented [KA3]: Although I am not a lawyer, I am wondering if you might want to end this sentence at "maximum extent practicable" so that items #1-5 don't appear to define what is MEP or reinterpret the requirements. I am not sure that #1-5 are necessary.

C. “Development or project” means any construction activity or alteration of the landscape, its terrain, contour or vegetation, including the erection or alteration of single or multiple structures, and any grading.

Commented [KA4]: Should this definition be replaced with a definition for “New Development” consistent with the City’s Post Construction standards?

“New Development means land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces; and land subdivision on an area that has not been previously developed.”

D. “Director” means the director of public works - engineering or his or her designee who is authorized to enforce compliance with this chapter.

E. “Direct discharge” means a discharge that is routed directly to waters of the United States by means of a pipe, channel, or ditch (including through the storm sewer system), or through surface runoff.

F. “Discharge” means any release, spill, leak, pumping, flow, escape or leaching, including subsurface migration to groundwater, dumping or disposal of any gas, liquid, semi-solid or solid substance, whether accidental or intentional.

G. “Discharge of a pollutant” means the addition of any pollutant or combination of pollutants to waters of the United States from any point source. The term includes additions of pollutants to waters of the United States from: surface runoff which is collected or channeled by man; discharges through pipes, sewers, or other conveyances owned by a state, municipality, or other person which do not lead to a treatment works; and discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works.

H. “Illicit discharge” means any discharge to the storm drain system that is prohibited under local, state, or federal statutes, ordinances, codes or regulations that is not composed entirely of storm water except discharges pursuant to a NPDES permit or discharges excepted under Section 15.50.050 of this chapter.

I. “Incidental runoff” is unintended amounts (volume) of runoff, such as unintended, minimal over-spray from sprinklers that escapes the area of intended use. Water leaving an intended use area is not considered incidental if it is part of the facility design, if it is due to excessive application, if it is due to intentional overflow or application, or if it is due to negligence.

J. “Linear underground/overhead projects (LUPs)” includes, but is not limited to ~~means~~ any conveyance, pipe, or pipeline for the transportation of any gaseous, liquid (including water and wastewater for domestic municipal services), liquescent, or slurry substance; and cable line or wire for the transmission of electrical energy; and cable line or wire for communications (e.g. telephone, telegraph, radio, or televisions messages); and associated ancillary facilities. Construction activities associated with LUPs include, but are not limited to, (a) those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment, and associated ancillary facilities); and include, but are not limited to, (b) underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/or pavement repair or replacement, and stockpile/borrow locations.

K. “Low impact development” means a sustainable practice that benefits water supply and contributes to water quality protection. Unlike traditional storm water management, which collects and conveys storm water runoff through storm drains, pipes, or other conveyances to a centralized storm water facility, low impact development (LID) takes a different approach by using site design and storm water management to maintain the site’s pre-development runoff rates and volumes. The goal of LID is to mimic a site’s predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall.

L. “Municipal separate storm sewer system (MS4)” means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) owned or operated by the City of Chico; (ii) designed or used for collecting or conveying storm water; and (iii) which is not part of a publicly owned treatment works as defined at 40 C.F.R. 122.2. [Also referred to as the municipal storm drain system]

M. “National Pollutant Discharge Elimination System (NPDES) permit” or “NPDES permit” means a discharge permit issued by the State Water Resources Control Board, the Regional Water Quality Control Board or the United States Environmental Protection Agency.

N. “Non-storm water discharge” means any discharge to the municipal storm drain system that is not entirely composed of storm water.

O. “Pollutant” means any contaminant that can degrade the quality of the receiving waters by altering pH, total suspended or settleable solids, biochemical oxygen demand, chemical oxygen demand, nutrients or temperature.

P. “Redevelopment” means land-disturbing activity that results in the creation, addition or replacement of exterior impervious surface area on a site which some past development has occurred. Redevelopment does not include trenching, excavation and resurfacing associated with LUPs; pavement grinding and resurfacing of existing roadways; construction of new sidewalks, pedestrian ramps, or bike lanes on existing roadways; or routine replacement of damaged pavement such as pothole repair or replacement of short, non-contiguous sections of roadway.

Q. “Storm drain system” means a conveyance or system of conveyances owned, operated or controlled by the city designed or used to convey storm water to waters of the United States. The conveyance system may include, but is not limited to, any roads with drainage systems, streets, catch basins, natural and artificial channels, aqueducts, stream beds, gullies, curbs, gutters, ditches, open fields, parking lots, impervious surfaces used for parking, and storm drains.

R. “Storm water” means water that originates from atmospheric moisture (rainfall, hail, snow or snowmelt) that falls onto land, water or other surfaces and any surface flow, runoff or drainage associated with such atmospheric events.

S. “Storm water pollution prevention plan” or “SWPPP” means a plan required by the State Water Resources Control Board, the Regional Water Quality Control Board or the United States Environmental Protection Agency which sets forth the site map, identifies

Commented [KA5]: Recommend including a definition for Maximum Extent Practicable

“The minimum required performance standard for implementation of municipal storm water management programs to reduce pollutants in storm water. MEP is the cumulative effect of implementing, evaluating, and making corresponding changes to a variety of technically appropriate and economically feasible BMPs, ensuring that the most appropriate controls are implemented in the most effective manner.

Commented [KA6]: Recommend making this definition consistent with the Post Construction Standards and the Phase II Permit.

“National Pollutant Discharge Elimination System (NPDES) – A national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the CWA.”

Commented [KA7]: Should this be modified to be consistent with the Phase II Permit?

Pollutant – Dredged spoil, solid waste, incinerator residue, filter backwash, sewage,garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.)), heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water

Commented [KA8]: Recommend including the definition for Regulated Project from the Post Construction Standards.

“Regulated Project – Refers to projects that will create and/or replace 5,000 ft2 of more of impervious surface. Regulated projects include new and redevelopment projects on public or private land that fall under the planning and permitting authority of the City. Regulated projects are subject to the City’s Post Construction Standards and the new and redevelopment standards in the Phase II Permit.”

the activities that have the potential to pollute storm water which may enter the city's storm drain system, describes the proposed BMPs to be implemented by the discharger, and contains a description of any other requirements that the State Water Resources Control Board, the Regional Water Quality Control Board or the United States Environmental Protection Agency requires the discharger to list in the SWPPP.

(Ord. 2439 §111, Ord. 2468 §1)

15.50.025 Legal authority.

The city has the legal authority to:

A. Effectively prohibit non-storm water discharges through the municipal separate storm sewer system (MS4). Exceptions to this prohibition are listed under Section 15.50.050.

B. Detect and eliminate illicit discharges and illegal connections to the MS4. Illicit connections include pipes, drains, open channels, or other conveyances that have the potential to allow an illicit discharge to enter the MS4. Illicit discharges include all non-storm water discharges not otherwise authorized in Section 15.50.050, including, but not limited to, discharges from privately owned septic systems; discharges of runoff from material storage areas; discharges from spills; and discharges from organized car washes, mobile cleaning and pressure wash operations.

C. Respond to the discharge of spills, and prohibit dumping or disposal of materials other than storm water into the MS4.

D. Require parties responsible for runoff in excess of incidental runoff to:

1. Detect leaks and correct the leaks within 72 hours of learning of the leak;

2. Properly design and aim sprinkler heads;

3. Not irrigate during precipitation events; and

4. Manage pond containing recycled water such that no discharge occurs unless the discharge is a result of a 25-year, 24-hour storm event or greater, and the appropriate regional water board is notified by email no later than 24 hours after the discharge. The notification is to include identifying information, including the permittee's name and permit identification number.

E. Require operators of construction sites, new or redeveloped land, and industrial and commercial facilities to minimize the discharge of pollutants to the MS4 through the installation, implementation, or maintenance of best management practices (BMPs) consistent with the California Storm Water Quality Association (CASQA) Best Management Practice Handbooks or equivalent.

Commented [KA9]: Replace with "small or regulated projects subject to the City's Post Construction Standards"?

F. Require information deemed necessary to assess compliance with this municipal code.

G. Review designs and proposals for ~~new development and redevelopment~~small and regulated projects subject to the City's Post Construction Standards to determine whether adequate BMPs will be installed, implemented, and maintained during construction and after final stabilization (post construction).

H. Require any discharger, engaged in activities or operations, or owning facilities or property which will or may result in pollutants entering storm water, the storm drain system, or waters of the U.S. to perform all necessary maintenance activities to the storm water control system as prescribed by the operation and maintenance ("O&M") plan and certificate of responsibility form applicable. If the system is not functioning as designed and permitted, the discharger, engaged in activities or operations, or owning facilities or property must perform the required maintenance immediately to restore the system.

I. Enter private property for the purpose of inspecting, at reasonable times, any facilities, equipment practices, or operations for active or potential storm water discharges, or non-compliance with Chapter 15.

J. Require that dischargers promptly cease and desist discharging and/or cleanup and abate a discharge, including the ability to:

1. Effectively require the discharger to abate and clean up their discharge, spill, or pollutant release within 72 hours of notification; high risk spill should be cleaned up as soon as possible.

2. Require abatement within 30 days of notification, for uncontrolled sources of pollutants that could pose an environmental threat.

3. Perform the clean-up and abatement work and bill the responsible party, if necessary;

4. Provide the option to order the cessation of activities until such problems are adequately addressed if a situation persists where pollutant-causing sources or activities are not abated; and/or

5. Require a new timeframe and notify the Central Valley Regional Water Board when all parties agree that clean-up activities cannot be completed within the original timeframe and notify the Central Valley Regional Water Board in writing within five business days of the determination that the timeframe requires revision.

K. Levy citations or administrative fines against responsible parties either immediately at the site or within a few days.

L. Require recovery and remediating costs from responsible parties.

M. Impose more substantial civil or criminal sanctions and escalate corrective response for persistent non-compliance, repeat or escalating violations, or incidents of major environmental harm.

N. Require compliance with Section 15.50.075 Construction site storm water runoff control.

O. Require compliance with Section 15.50.080 Post construction storm water management.

P. The city has the legal authority to inspect public and private construction projects and conduct enforcement as necessary.

(Ord. 2468 §2)

15.50.030 General provisions.

This chapter shall be administered by the Director and shall be construed to assure consistency with the requirements of the federal Clean Water Act, applicable implementing regulations, and any City NPDES permits as amended, revised or reissued. In the event of any conflict between this chapter and any federal or state law, regulation, order or permit, the requirement that establishes the higher standard for public health or safety shall govern. Nothing in this chapter shall preclude enforcement of any other applicable law, regulation, order or permit. Nothing in this chapter is intended to diminish or preempt the authority of the fire department to investigate, clean-up or abate the effects of any hazardous materials under state law or applicable sections of this code, and any such actions of the fire department shall be in addition to, and not in place of, measures set forth in this chapter.

15.50.040 Prohibited activities.

A. Illicit Discharge. Non-storm water discharges to the City's storm drain system are prohibited except as specifically permitted under Section 15.50.050.

B. Discharge in Violation of Permit. Any discharge that would result in, or contribute to, a violation of the City's NPDES permit as amended, revised or reissued, either separately considered or when combined with other discharges, is a violation of this chapter and is prohibited. Liability for any such discharge shall be the responsibility of the person causing or responsible for the discharge as well as the property owner from whose property the discharge occurs or originates. Such responsible persons shall be strictly liable for discharges in violation of the City's NPDES permit and such persons shall defend, indemnify and hold harmless the City in any administrative or judicial enforcement act relating to such discharge.

15.50.050 Exceptions to discharge prohibition.

The following discharges are exempt from the prohibitions set forth in Section 15.50.040 above:

A. Any discharge regulated under a NPDES permit issued to the discharger provided that the discharger is in compliance with all requirements of the permit and all other applicable laws and regulations.

B. Discharges from the following non-storm water activities unless identified by either the city or the Regional Water Quality Control Board as a significant source of pollutants to waters of the United States:

1. Water line flushing;
2. Diverted stream flows;
3. Rising ground waters;

4. Uncontaminated ground water infiltration (as defined at 40 C.F.R. § 35.2005(20)) to separate storm sewers;

5. Uncontaminated pumped ground water;

6. Discharges from potable water sources;

7. Foundation drains;

8. Air conditioning condensation;

9. Springs;

10. Water from crawl space pumps;

11. Footing drains;

12. Individual residential car washing;

13. Flows from riparian habitats and wetlands;

14. Dechlorinated swimming pool discharges;

15. Discharges or flows from fire fighting activities;

16. City municipal storm drain maintenance line clearing activities; and

17. Incidental runoff from landscaped areas (in accordance with below):

a. Discharges in excess of an amount deemed to be incidental runoff shall be controlled.

b. Non-storm water runoff discharge that is not incidental is prohibited, unless otherwise listed above in B.1 - B.16~~7~~.

c. Incidental runoff may be regulated by waste discharge requirements or, where necessary, waste discharge requirements that serve as a NPDES permit, including MS4 permits.

(Ord. 2468 §3)

15.50.060 Discharges in violation of an industrial or construction activity NPDES storm water discharge permit.

Any person subject to a construction activity NPDES storm water discharge permit shall comply with all provisions of such permit. Proof of compliance with the permit shall be submitted to the Director or his or her designee, if so requested. Proof of compliance shall include a copy of the notice of intent (NOI) submitted to the State Water Resources Control Board, the SWPPP for the construction project, and the waste discharge identification (WDID) number provided by the State Water Resources Control Board. Construction activity permits are required for construction projects disturbing one acre or more of land. Construction activities of any size are also subject to the City's grading regulations at Titles 16 and 16R of this code.

Commented [KA10]: FYI – this is the one item that is not included within the Discharge Prohibitions for the Phase II Permit. Not sure that this is accurate.

Commented [KA11]: Prohibited? How is controlled defined?

The Director or his or her designee shall, at any time, have the authority to inspect construction sites to ensure compliance with the measures outlined in the SWPPP for the projects and to implement the enforcement measures of this chapter and Chapters 1.12 and 1.14 of this code.

15.50.070 Requirement to prevent, control and reduce storm water pollutants.

The City will require implementation of BMPs for any activity, operation or facility that may cause or contribute to pollution or the contamination of storm water, the storm drain system or waters of the United States. Where BMP requirements are promulgated by the City or any federal, state or regional agency for any activity, operation or facility which would otherwise cause the discharge of pollutants to the storm drain system or waters of the United States, every person undertaking such activity or operation, or owning or operating such facility, shall comply with such requirements.

15.50.075 Construction site storm water runoff control.

A. Applicability. All projects that disturb soil are subject to the construction site storm water runoff control requirements. Projects that disturb one acre or more of soil or disturb less than one acre but are part of a larger common plan or development or sale are subject to the State Water Board's construction general permit in addition to the construction site storm water runoff control requirements.

B. Construction Plan Review and Approval Procedures.

1. Prior to issuing a grading or building permit, the City of Chico shall require each operator of a construction activity within the city's jurisdiction to prepare and submit for review and approval an erosion and sediment control plan (ESCP) per the city's approved ESCP form. The ESCP shall contain appropriate site-specific construction site BMPs that meet the minimum requirements to control storm water pollution due to construction activities. The city holds the right to require additional specific BMPs before approving the ESCP.

a. The storm water pollution prevention plan (SWPPP) developed pursuant to the construction general permit may substitute for the ESCP for projects where a SWPPP is developed. The city holds the right to require additional BMPs before approving the SWPPP.

2. The ESCP shall include the rationale used for selecting BMPs including, if necessary, supporting soil loss calculations. The ESCPs shall contain, as needed, erosion and sediment controls, soil stabilization, dewatering, source controls, and pollution prevention measures per the CASQA Best Management Practices Handbooks or as approved by the city.

3. The ESCP shall list all applicable permits directly associated with any grading activity, including State Water Boards' construction general permit, State Water Boards' 401 water quality certification, U.S. Army Corps of Engineers 404 permit, and the California Department of Fish and Wildlife 1600 streambed alteration agreement. The responsible party shall submit evidence to the City of Chico that all permits directly

associated with the grading activity have been obtained prior to commencing the soil disturbing activities authorized by the grading permit.

4. Construction sites are subject to Section 15.50.040 Prohibited activities.

C. Construction Site Inspection and Enforcement.

1. The city has the legal authority to inspect public and private construction projects and conduct enforcement as necessary.

(Ord. 2468 §4)

15.50.080 Post construction storm water management.

A. Site Design Measures.

1. All projects that create and/or replace (including projects with no net increase in impervious footprint) between 2,500 square feet and 5,000 square feet of impervious surface, including detached single family homes that create and/or replace 2,500 square feet or more of impervious surface and are not part of a larger plan of development are required to implement one or more of the following site design measures to reduce project site runoff:

a. Stream setbacks and buffers – a vegetated area including trees, shrubs, and herbaceous vegetation, that exists or is established to protect a stream system;

b. Soil quality improvement and maintenance – improvement and maintenance soil through soil amendments and creation of a healthy microbial community;

c. Tree planting and preservation – planting and preservation of healthy, established trees that include both evergreens and deciduous;

d. Porous pavement – pavement that allows runoff to pass through it and infiltrate into the underlying soils, thereby reducing the runoff from a site and surrounding areas and filtering pollutants;

e. Green roofs – an engineered vegetative layer grown on a roof that allows a certain amount of runoff reduction by infiltration, storage, and evapo-transpiration.

f. Vegetated Swales - a vegetated, open-channel management practice designed specifically to treat and attenuate storm water runoff; and/or

f. Rain barrels and cisterns – system that collects and stores storm water runoff from a roof or other impervious surface.

2. This section is not applicable to linear underground/overhead projects.

3. Project proponents shall use the State Water Board SMARTS post-construction calculator to quantify and submit to the City of Chico the runoff reduction resulting from implementation of site design measures.

4. The plans for the site design measures required in this section shall be stamped by:

Commented [KA12]: FWIW – this section does not describe the 3-step process in the Post Construction Standards.

Commented [KA13]: The City's Post Construction Standards also has – Rooftop and Impervious Area Disconnection, but the ordinance does not have this category.

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a. A California civil professional engineer for rooftop and impervious area disconnections, porous pavement, rain cisterns, bioretention and rain gardens, infiltration trenches, retention or detention basins, or green roofs; and

Commented [KA14]: These are not specifically listed in this section.

b. A California landscape architect for soil quality improvements, vegetated swales, or biorentention and rain gardens.

Commented [KA15]: These are not specifically listed in this section.

B. Regulated Projects – Projects that create and/or replace 5,000 square feet or more of impervious surface.

1. All Regulated P~~p~~rojects ~~that create and/or replace 5,000 square feet or more of impervious surface~~ are required to implement measures for site design, source control, runoff reduction, storm water treatment and baseline hydromodification management. ~~These projects are considered regulated projects.~~

a. Regulated projects do not include detached single family home projects that are not part of a larger plan of development; interior remodels; routine maintenance or repairs such as exterior wall surface replacement or pavement resurfacing within the existing footprint; and LUPs.

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i. LUPs that have a discrete location of 5,000 square feet or more of newly constructed contiguous impervious surface are considered a regulated project for that specific discrete location.

2. Regulated projects include development projects. Development includes new and redevelopment projects on public or private land that fall under the permitting authority of the city. Redevelopment is any land-disturbing activity that results in the creation, addition, or replacement of exterior impervious surface area on a site on which some past development has occurred. Redevelopment does not include trenching, excavation and resurfacing associated with LUPs; pavement grinding and resurfacing of existing roadways; construction of new sidewalks, pedestrian ramps, or bike lanes on existing roadways; or routing replacement of damaged pavement such as a pothole repair or replacement of short, non-contiguous sections of roadway. The following describe specific regulated project requirements:

a. Redevelopment Projects –

i. Where a redevelopment project results in an increase of more than 50 percent of the impervious surface of a previously existing development, runoff from the entire project, consisting of all existing, new, and/or replaced impervious surfaces, must be included to the extent feasible.

ii. Where a redevelopment project results in an increase of less than 50 percent of the impervious surface of a previously existing development, only runoff from the new and/or replaced impervious surface of the project must be included.

b. Road Projects and LUPs – Any of the following types of road projects and LUPs that create 5,000 square feet or more of newly constructed contiguous impervious surface and that are public road projects and/or fall under the permitting authority of the city shall comply with Section 15.50.080(D) Low impact development design standards, except that treatment of runoff of the 85th percentile that cannot be infiltrated onsite shall follow U.S. Environmental Protection Agency's guidance regarding green infrastructure to the extent feasible.

i. Construction of new streets or roads, including sidewalks and bicycle lanes built as part of the new streets or roads.

ii. Widening of existing streets or roads with additional traffic lanes.

a. Where the addition of traffic lanes result in an alteration of more than 50 percent of the impervious surface of an existing street or road, runoff from the entire project, consisting of all existing, new, and/or replaced impervious surfaces, must be included in the treatment system design.

b. Where the addition of traffic lanes result in an alteration of less than 50 percent (but 5,000 square feet or more) of the impervious surface of an existing street or road, only the runoff from new and/or replaced impervious surface of the project must be included in the treatment system design.

iii. Construction of linear underground/overhead projects (LUPs).

iv. Specific exclusions are:

a. Sidewalks built as part of new streets or roads and built to direct storm water runoff to adjacent vegetated areas.

b. Bicycle lanes that are built as part of new streets or roads that direct storm water runoff to adjacent vegetated areas.

c. Impervious trails built to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas, preferably away from creeks or towards the outboard side of levees.

d. Sidewalks, bicycle lanes, or trails constructed with permeable surfaces.

e. Trenching, excavation and resurfacing associated with LUPs; pavement grinding and resurfacing of existing roadways and parking lots; construction of new sidewalks, pedestrian ramps, or bike lanes on existing roadways; or routine replacement of damaged pavement such as pothole repair or replacement of short, non-contiguous sections of roadway.

C. Source Control Measures.

1. Regulated projects with pollutant-generating activities and sources are required to implement standard permanent and/or operation source control measures. The measures for the following pollutant generating activities and sources shall be designed consistent with recommendations from the CASQA Storm Water BMP Handbook for New Development and Redevelopment or equivalent manual:

a. Accidental spills or leaks

b. Interior floor drains

c. Parking/storage areas and maintenance

d. Indoor and structural pest control

e. Landscape/outdoor pesticide use

f. Pools, spas, ponds, decorative fountains, and other water features

g. Restaurants, grocery stores, and other food service operations

h. Refuse areas

i. Industrial processes

j. Outdoor storage of equipment or materials

k. Vehicle and equipment cleaning

l. Vehicle and equipment repair and maintenance

m. Fuel dispensing areas

n. Loading docks

o. Fire sprinkler test water

p. Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources

q. Unauthorized non-storm water discharges

r. Building and grounds maintenance

D. Low Impact Development (LID) Design Standards – All regulated projects are required to implement LID standards as listed below.

1. Site Assessment – Regulated projects are required to assess and evaluate how site conditions, such as soils, vegetation, and flow paths, will influence the placement of buildings and paved surfaces. The evaluation will be used to meet the goals of capturing and treating runoff and assuring these goals are incorporated into the project design. The following methods are required to be completed to optimize the site layout of the project site:

a. Define the development envelope and protected areas, identifying areas that are most suitable for development and areas to be left undisturbed.

b. Concentrate development on portions of the site with less permeable soils and preserve areas that can promote infiltration.

c. Limit overall impervious coverage of the site with paving and roofs.

d. Set back development from creeks, wetlands, and riparian habitats.

e. Preserve significant trees.

f. Conform the site layout along natural landforms.

g. Avoid excessive grading and disturbance of vegetation and soils.

h. Replicate the site's natural drainage patterns.

i. Detain and retain runoff throughout the site.

2. Drainage Management Areas – Each regulated project is required to provide a map or diagram dividing the developed portions of the project site into discrete drainage management areas (DMAs), and to manage runoff from each DMA using site design measures, source controls and/or storm water treatment and baseline hydromodification measures.

3. Numeric Sizing Criteria for Storm Water Retention and Treatment – Facilities designed to evapotranspire, infiltrate, harvest/use, and biotreat storm water are required to meet at least one of the following hydraulic sizing design criteria:

Commented [KA16]: For trash – we would want to build in the design criteria in this or another section.

a. Volumetric Criteria:

i. The maximized capture storm water volume for the tributary area, on the basis of historical rainfall records, determined using the formula and volume capture coefficients in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87 (1998) pages 175-178 (that is, approximately the 85th percentile 24-hour storm runoff event); or

ii. The volume of annual runoff required to achieve 80 percent or more capture, determined in accordance with the methodology in Section 5 of the CASQA's Storm Water Best Management Practice Handbook, New Development and Redevelopment (2003), using local rainfall data.

b. Flow-based Criteria:

i. The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity; or

ii. The flow of runoff produced from a rain event equal to at least 2 times the 85th percentile hourly rainfall intensity as determined from local rainfall records.

4. Site design measures as defined in Section 15.50.080(A) above, site layout, and design measures shall be implemented on the objective of achieving infiltration, evapotranspiration and/or harvesting/reuse of the 85th percentile 24-hour storm runoff event. Site design measures shall be used to reduce the amount of runoff, to the extent technically feasible, for which retention and runoff is required. Any remaining runoff from impervious DMAs may then be directed to one or more bioretention facilities as specified in Section 15.50.080(D)(6) below.

5. Source Controls – All regulated projects shall implement source controls as defined in Section 15.50.080(C) above.

6. Storm Water Treatment Measures and Baseline Hydromodification Management Measures – After implementation of site design measures on regulated projects, the remaining runoff from impervious DMAs must be directed to one or more facilities designed to infiltrated, evapotranspire, and/or bioretain the amount of runoff specified in Section 15.50.080(D)(3) Numeric sizing criteria for storm water retention and

treatment. The facilities must be demonstrated to be at least as effective as a bioretention system with the following design parameters:

a. Maximum surface loading rate of 5 inches per hour, based on the flow rates calculated. A sizing factor of 4% of tributary impervious area may be used.

b. Minimum surface reservoir volume equal to surface area times a depth of 6 inches.

c. Minimum planting medium depth of 18 inches. The planting medium must sustain a minimum infiltration rate of 5 inches per hour throughout the life of the project and must maximize runoff retention and pollutant removal. A mixture of sand (60%-70%) meeting the specifications of American Society for Testing and Materials (ASTM) C33 and compost (30%-40%) may be used.

d. Subsurface drainage/storage (gravel) layer with an area equal to the surface area and having a minimum depth of 12 inches.

e. Underdrain with discharge elevation at top of gravel layer.

f. No compaction of soils beneath the facility, or ripping/loosening of soils if compacted.

g. No liners or other barriers interfering with infiltration.

h. Appropriate plant palette for the specified soil mix and maximum available water use.

7. Alternative Designs – Facilities, or a combination of facilities, of a different design than in Section 15.50.080(D)(6) may be permitted if all of the following measures of equivalent effectiveness are demonstrated:

a. Equal or greater amount of runoff infiltrated or evapotranspired;

b. Equal or lower pollutant concentrations in runoff that is discharged after biotreatment;

c. Equal or greater protection against shock loadings and spills;

d. Equal or greater accessibility and ease of inspection and maintenance.

8. Allowed Variations for Special Site Conditions – The bioretention system design parameters Section 15.50.080(D)(6) may be adjusted for the following special site conditions:

a. Facilities located within 10 feet of structures or other potential geotechnical hazards established by the geotechnical expert for the project may incorporate an impervious cutoff wall between the bioretention facility and the structure or other geotechnical hazard.

b. Facilities with documented high concentrations of pollutants in underlying soil or groundwater, facilities located where infiltration could contribute to a geotechnical hazard, and facilities located on elevated plazas or other structures may incorporate an impervious liner and may located the underdrain discharge at the bottom of the subsurface drainage/storage layer (this configuration is commonly known as a “flow-through planter”).

c. Facilities located in areas of high groundwater, highly infiltrative soils or where connection of underdrain to a surface drain or to a subsurface storm drain are infeasible, may omit the underdrain.

d. Facilities serving high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites may be required to provide additional treatment to address pollutants of concern unless these high-risk areas are isolated from storm water runoff or bioretention areas with little chance of spill migration.

9. Exceptions to Requirements of Bioretention Facilities –

Contingent on a demonstration that use of bioretention or a facility of equivalent effectiveness is infeasible, other types of biotreatment or media filters (such as tree-box-type biofilters or in-vault media filters) may be used for the following categories of regulated projects:

a. Projects creating or replacing an acre or less of impervious area, and located in a designated pedestrian-oriented commercial district, and having at least 85% of the entire project site covered by permanent structures;

b. Facilities receiving runoff solely from existing (pre-project) impervious areas; and

c. Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity.

E. Hydromodification Management – Hydromodification management projects are regulated projects that create and/or replace one acre or more of impervious surface. A project that does not increase impervious surface area over the pre-project condition is not a hydromodification management project. Post-project runoff for hydromodification management projects shall not exceed estimated pre-project flow rate for the 2-year, 24-hour storm.

F. Operations and Maintenance of Post-Construction Storm Water Management Measures – All regulated projects shall at a minimum, require from all project proponents and their successors in control of the project or successors in fee title:

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1. The property owner or responsible party shall sign a statement of responsibility accepting responsibility for the on-going operation, inspection, and maintenance of the treatment control measures until the property and/or responsibility is legally transferred to another entity. The statement of responsibility shall be on a form approved by the city.

a. The transfer of property to a new owner shall contain conditions requiring the recipient to assume responsibility for maintenance of any treatment control measures to be included in the sales or lease agreement for that property and will be the owner’s responsibility. The new owner or responsible party will be obligated to maintain the operations and maintenance of the treatment control measures.

2. The city will send the responsible party an operation and maintenance self-certification form. The responsible party will certify that the operations and maintenance program is being implemented and that the treatment control measures are in an effective operational condition. The responsible party will have sixty (60) days to complete and return the annual operation and maintenance self-certification form.

a. If the operation and maintenance self-certification form is not received within the sixty (60) day period, the city will perform the inspection and assessment. The responsible party will be billed for the inspection and assessment as applicable.

G. All projects subject to this section shall submit a completed post construction storm water worksheet to the city.

(Ord. 2468 §5)

15.50.090 Grading activity and permits.

All grading work shall be performed in compliance with Titles 16 and 16R of this code and all construction or development activity, including clearing, grading or excavation, whether requiring a grading permit or not, shall be undertaken in accordance with all requirements of this chapter.

15.50.100 Inspection authority.

A. Whenever necessary to make an inspection of any building or property to enforce any of the provisions of this chapter, or whenever the Director has reasonable cause to believe that there exists in any building or upon any property any condition that constitutes a violation of this chapter, the Director may enter such building or property at all reasonable times to perform an inspection as well as any of the other activities authorized by this chapter. If an owner, tenant, occupant, agent or other responsible party refuses to grant the City permission to enter or inspect, the City may seek an inspection warrant pursuant to the Code of Civil Procedure.

B. Routine or area inspections shall be based upon such reasonable selection processes as may be deemed necessary to carry out the objectives of this chapter, including but not limited to, random sampling and/or sampling in areas with evidence of storm water contamination, illicit discharges, discharge of non-storm water to the storm drain system or similar evidence.

C. The Director may enter and inspect property for which a grading permit has been applied to determine the applicability of, or compliance with, this chapter and City specifications. The Director may also inspect any and all property on which grading, filling, clearing, and grubbing or excavating activities are occurring to ensure compliance with this chapter.

15.50.110 Sampling, monitoring, analysis and reporting authority.

A. During any inspection the Director may collect samples as necessary in order to implement and enforce the provisions of this chapter. This authority shall include the right to require the installation of sampling and metering devices on private property or to require the person owning or occupying the property to supply samples.

B. During any inspection the Director may require the person owning or occupying the property to provide any and all records relating to any potential storm water contamination, illegal discharge, non-storm water discharge or other violation of this chapter for review and copying.

C. Whenever the Director has reasonable cause to believe that there may exist on any property a condition that constitutes a violation of this chapter, the Director may require monitoring, analysis and/or reporting of discharges from the property to the storm drain system by serving a written notice of such requirement(s) on the owner of the property or on the operator of a facility or activity on the property. The cost of complying with these requirements shall be borne by the owner of the property or the operator of the facility or activity for which monitoring, analysis and/or reporting has been required, to the extent permitted by law.

15.50.120 Containment and notification of spills.

Any person owning, occupying or responsible for property or responsible for emergency response for a facility or activity has a personal responsibility to train facility personnel and maintain notification procedures to assure immediate notification is provided to the City of any suspected, confirmed or unconfirmed release of materials, pollutants or wastes creating a risk of discharge to the City's storm drain system. As soon as any person owning, occupying or responsible for the property or responsible for emergency response for a facility or activity has knowledge of any suspected, confirmed or unconfirmed release, such person shall take all necessary steps to ensure the discovery, containment and clean-up of such release and shall immediately notify the Director by telephone of the release and shall confirm the notification by written correspondence within 24 hours of such knowledge.

15.50.130 Enforcement powers and remedies.

The Director may utilize any enforcement actions authorized or provided in this code including, but not limited to, administrative remedies as set forth in Chapter 1.14 of this code. The Director may also exercise any of the following enforcement actions deemed necessary:

A. Abatement

1. Any discharge or condition violating any provisions of this chapter is a threat to the public health, safety and welfare and constitutes a public nuisance.

2. The Director may abate any discharge or condition that violates any provision of this chapter in accordance with the provisions of Chapter 1.14 of this code and such action by the Director shall be subject to appeal as provided for in that chapter. In addition, any notice and order issued by the Director under Chapter 1.14 of this code may require the owner and/or occupant of the subject property to take any or all of the following actions:

a. Submit and implement a plan approved by the Director for the correction and prevention of the discharge or condition violating any provision of this chapter;

b. Cease and desist all activities that may cause or contribute to any discharge or condition violating any provision of this chapter;

c. Clean-up any release of pollutants causing or resulting from the violation of any provision of this chapter;

d. Mitigate any circumstances that may cause or contribute to any discharge or condition violating any provision of this chapter; and

e. Adopt and implement BMPs and/or a storm water pollution prevention plan approved by the Director.

3. If any violation of this chapter constitutes a seasonal and recurrent nuisance, the Director shall so declare in the notice and order issued pursuant to subsection 2 above. Thereafter, the owner or occupant of the subject property shall abate such seasonal and recurrent nuisance every year without the necessity of any further notice and order. If at any time following the issuance of the notice and order the nuisance is not abated as required, the Director may summarily abate the condition in accordance with provisions of Chapter 1.14 of this code.

4. When, in the opinion of the Director, any discharge from any source to the storm drain system causes or threatens to cause a condition that presents an imminent hazard to the public health, safety or welfare or the environment, or a violation of the City's NPDES permit, the Director may issue a notice requiring the owner or occupant of the property where the discharge is occurring to immediately abate the discharge. In any case where the discharge is not immediately abated or the Director determines that time constraints are such that abatement must occur without providing the notice, the Director may summarily abate the condition in accordance with the provisions of Chapter 1.14 of this code.

5. The owner of any property from which a discharge is made in violation of this chapter and any person making or causing the discharge, if different from the owner, shall be jointly and severally liable for the costs incurred by the City for any abatement, clean-up or restoration, including any related inspection and testing costs arising from the discharge and the costs shall be invoiced to the owner of the property and any responsible persons. If the invoice is not paid within sixty (60) days, the Director may commence proceedings for recovery of these costs in accordance with the provisions of Chapter 1.14 of this code.

B. Civil Actions

In addition to any other remedies or penalties provided in this chapter, any violation of this chapter may be enforced by civil action brought by the City Attorney. In any such action the City may seek, as appropriate, any or all available equitable and legal remedies including but not limited to:

1. A temporary or permanent injunction;

2. Assessment upon the violator for the costs of any investigation, inspection, testing or monitoring related to the violation and for the reasonable costs of preparing and bringing legal action under this subsection including attorney fees, whether for in-house or outside counsel;

3. Costs incurred in removing, correcting, abating, cleaning-up or terminating the adverse effects resulting from the violation;

4. Compensatory damages for damage, loss or destruction to water quality, wildlife, fish and aquatic life, or public health and safety;

5. Payment or reimbursement of any governmental fines or penalties imposed on the City as a result of the violation; and

6. Payment of a fine of up to $5,000 for each day or portion of a day that the discharge occurs.

C. Criminal Violations

A violation of any of the provisions of this chapter shall constitute a misdemeanor, except that notwithstanding any other provision of this code, any such violation may, at the discretion of the City Attorney, be charged and prosecuted as an infraction.

15.50.140 Appeal.

If a decision or action by the Director is not subject to an appeal procedure under any other provision of this code, any person who is affected by the Director's decision or action may appeal the decision or action to the City Manager within ten (10) days following the effective date of the decision or action by filing a written appeal with the City Manager. Upon receipt of such appeal, the City Manager may request a report and recommendation from the Director and shall set the matter for an informal hearing at the earliest practical date. Not less than seven (7) days prior to the date of the hearing, the City Manager shall provide written notice of the hearing to the person appealing the decision or action. At the hearing, the appellant may be represented by any person of appellant's choice. The City Manager shall hear any additional evidence presented by the appellant or the Director and may reject, affirm or modify the Director's decision or action. The City Manager's decision shall be the City's final administrative determination of the matter.

15.50.150 Judicial review.

The provisions of Sections 1094.5 and 1094.6 of the Code of Civil Procedure set forth the sole procedure for judicial review of any action taken pursuant to this chapter. Parties seeking judicial review of any final action taken pursuant to this chapter shall file such action within ninety (90) calendar days after the occurrence of any event or receipt of any decision constituting the evaluation of administrative remedies provided in this chapter for which review is sought.

15.50.160 Ultimate responsibility of discharger.

The standards established by this chapter are minimum standards and do not imply that compliance by any discharger will ensure that there will not be any contamination, pollution nor unauthorized discharge of pollutants to the City's storm drain system or waters of the United States. This chapter shall not create liability on the part of the City or any city employee for any damages that result from any discharger's reliance on this chapter or any lawful administrative decision.

15.50.170 Remedies cumulative.

The remedies provided in this chapter shall be cumulative and not exclusive and shall be in addition to any and all remedies available to the City.

(Ord. 2384)

City of Chico

Storm Water Master Plan

Appendix A.2 – Floodplain Regulations

City of Chico Municipal Code – Chapter 16 Floodplain Regulations

16.34 General Provisions

16.34.010 Purpose.

The floodplain regulations set forth in this title are adopted pursuant to the municipal affairs provisions of the City Charter for the purpose of regulating the construction and installation of buildings, structures and other development occurring within special flood hazard areas of the city in a manner which insures that such development is properly elevated, floodproofed, or otherwise protected from flood damage, and in a manner which prevents obstructions in such flood hazard areas which cause or contribute to an increase in flood heights and velocities, all in order to minimize private and public losses due to flood conditions and otherwise protect the public's health, safety and welfare. The floodplain regulations set forth in this title are also adopted in accordance with the provisions of the National Flood Insurance Program so that flood insurance may be made available to the owners and occupants of property within the city at reasonable rates.

(Ord. 2131 §4. Ord. 2370 §3)

16.34.020 Administration of floodplain regulations.

The building official shall be primarily responsible for the administration of the floodplain regulations adopted by this title, subject to the overall direction and control of the director. In carrying out such responsibilities, the duties of the building official shall include, but not be limited to, maintenance of all of the floodplain maps, reports and other data required by Chapter 16.36 of this title, application of the floodplain standards adopted by or pursuant to Chapter 16.37 of this title, and undertaking enforcement actions provided for in Chapter 16.38 of this title.

(Ord. 2131 §4, Ord. 2364 §327, Ord. 2370 §4)

16.34.030 Manner of serving notices.

Any notice required to be served on a person pursuant to the provisions of the floodplain regulations adopted by this title shall be deemed served when made in writing and either personally delivered to such person or deposited in the U.S. mail, registered and postage prepaid, addressed to such person's last known address. However, when a notice is required to be served on the owner of any property, such notice may be served by depositing a copy of same in the U.S. mail, registered and postage prepaid, addressed to the owner at the owner's address as it appears on the last equalized or supplemental assessment roll of the County of Butte. Service of a notice by mail in a manner provided by this section shall be effective on the date of mailing. The failure of any person to receive such notice shall not affect the validity of the notice.

(Ord. 2131 §4, Ord. 2268)

16.34.040 Administrative review of determination or action of the building official by the director.

A. Right to Administrative Review. Any person aggrieved by a determination made or action taken by the building official under the floodplain regulations adopted by this title may apply to the director for administrative review of such determination or action.

B. Applications for Administrative Review. Applications for the administrative review of a determination made or action taken by the building official shall be in writing and shall be filed in the office of the director no later than 10 days following the date such determination or action was made or taken, or , where a written notice of such determination or action is required to be served no later than 10 days following the date such notice is served. The director may extend the time for filing an application for administrative review of a determination made or action taken by the building official for good cause shown. In addition to setting forth a request for administrative review of a determination made or action taken by the building official, such application shall contain a brief statement of the reasons why the applicant believes such determination or action does not comply with the floodplain regulations adopted by this title and the relief requested by the applicant from such determination or action.

C. Decision on Application for Administrative Review. Upon the filing of an application for administrative review of a determination made or action taken by the building official, the director shall consider the application and render a decision either affirming the determination or action of the building official or reversing or modifying such determination or action. Prior to rendering a decision, the director may, with sole discretion, convene an informal hearing for the purpose of reviewing evidence or hearing arguments bearing on such decision. Notice of the date, time, and place of such hearing shall be served a reasonable time prior to the hearing on the applicant and any other person who would be aggrieved by a decision reversing or modifying the determination or action of the building official and who has filed with the director a written request for notice of such decision. After rendering a decision, the director shall promptly inform the building official of the decision and cause a notice of the decision to be served on the applicant and any other person who would be aggrieved by a decision reversing or modifying the determination or action of the building official and who has filed with the director a written request for notice of such decision.

(Ord. 2131 §4, Ord. 2268, Ord. 2364 §328, Ord. 2370 §5)

16.34.050 Appeal from decision of community development director.

Any person aggrieved by a decision of the community development director following the filing of an application for the administrative review of a determination made or action taken by the building official, may appeal such decision to the city council within the time and in the manner provided for by Title 2 of this code.

(Ord. 2131 §4)

16.34.060 Administrative review and appeals - Aggrieved person.

A person shall be deemed “aggrieved,” for the purposes of the administrative review of a determination made or action taken by the building official or for purposes of the appeal of a decision of the community development director following the filing of an application for administrative review, if such determination, action or decision has a significantly greater effect on such person than on the public in general.

(Ord. 2131 §4)

16.34.070 Floodplain regulations required by federal or state law.

The floodplain regulations adopted by this title shall not apply to nor govern any condition where the local regulation of such condition is preempted by any federal or state law. Provided, however, that the purpose of this section is merely to confirm existing law and is not intended to grant an exemption or exclusion from compliance with the city's floodplain regulations in any instances where the city may exercise jurisdiction under the laws of the federal and state government as well as the City Charter and this code.

(Ord. 2131 §4)

16.34.080 Changes in Base Flood Elevations.

Within six months of information becoming available to the director of a change of base flood elevation within the City, the director shall submit, or cause an applicant for a building permit to submit, the technical or scientific data of that change to FEMA for a letter of map revision.

(Ord. 2370 §6)

16.34.090 Disclaimer of liability.

The degree of flood protection provided by this title is considered reasonable and is based on scientific and engineering considerations. Longer floods can and will occur on some occasions. Flood heights may be increased by man-made or natural conditions. The provisions of this title do not imply that land outside the areas of special flood hazards or uses permitted within such areas will be free from flooding or flood damage. The floodplain regulations of this title shall not create liability on the part of the city, any officer of employee thereof, the State of California, or the Federal Emergency Management Agency, for any flood damages that result from reliance on these regulations or any administrative decision lawfully made thereunder.

(Ord. 2370 §7)

16.34.100 Severability.

The floodplain regulations in this title are hereby declared to be severable. Should any section of the floodplain regulations be declared by a court to be invalid, such decision shall not affect the validity of the regulations as a whole, or any portion thereof other than the section so declared to be invalid.

(Ord. 2370 §8)

16.35 Definitions

16.35.010 General provisions.

Unless the contrary is stated or clearly appears from the context, the definitions set forth in this chapter shall govern construction of the words and phrases used in the floodplain regulations adopted in this title.

(Ord. 2131 §5)

16.35.020 ~~Department of Water Resources (DWR)~~Base flood.

The term “base flood” means a flood which has a one percent chance of being equaled or exceeded in any given year (also called the “100-year flood”).

(Ord. 2131 §5)

16.35.025~~30~~ Department of Water Resources (DWR)~~Development~~.

"Department of Water Resources (DWR)" means the California Department of Water Resources (DWR), a State agency which is part of the California Natural Resources Agency. The DWR is responsible for the State of California's management and regulation of water usage. The California Department of Water Resources was charged under SB 5 and SB 1278 with the development of the 2013 Urban Level of Flood Protection criteria.

(Ord. 2131 §5)

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16.35.030 Development.

The term “development” means any man-made change to improved or unimproved real property including, but not limited to, buildings or structures, grading, paving, drilling operations or the storage of equipment or materials.

(Ord. 2131 §5)

16.35.035 Federal Flood Standard.

"Federal Flood Standard" is the 100-year flood or 1 percent annual chance flood. See "100-year floodplain" definition.

(Ord. 2131 §5)

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16.35.040 Flood.

The term “flood” means the temporary condition of partial or complete inundation of normally dry land areas from the overflow of water, the unusual and rapid accumulation or runoff of surface waters from any source, mudslides (i.e., mudflows), and/or conditions resulting from flood-related erosion.

(Ord. 2131 §5)

16.35.042 Flood Hazard Zone.

"Flood Hazard Zone" means an area subject to flooding that is delineated as either a special hazard area or an area of moderate hazard on an official flood insurance rate map issued by the Federal Emergency Management Agency. The identification of flood hazard zones does not imply that areas outside the flood hazard zones, or uses permitted within flood hazard zones, will be free from flooding or flood damage.

(Ord. 2131 §5)

16.35.043 Flood insurance rate map.

The term “flood insurance rate map” or “FIRM” means an official map on which the Federal Emergency Management Agency or Federal Insurance Administration has delineated the areas of special flood hazards and the risk premium zones applicable to the community.

(Ord. 2370 §9)

16.35.047 Flood insurance map study.

The term “flood insurance map study” means the official report provided by the Federal Insurance Administration that includes flood profiles, the flood insurance rate map, and special flood hazard areas.

(Ord. 2370 §10)

16.35.050 Floodplain.

The term “floodplain” means any land area susceptible to being inundated by water from any source.

(Ord. 2131 §5)

16.35.060 Floodway or Regulatory Floodway.

The term “floodway” or “regulatory floodway” means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

(Ord. 2131 §5, Ord. 2370 §11)

16.35.065 Historic structures.

The term “historic structure” means any structure that is:

A. Listed individually in the National Register of Historic Places maintained by the U.S. Department of Interior or preliminarily determined by the Secretary of the Interior Department as meeting the requirements for individual listing on the National Register;

B. Certified or preliminarily determined by the Secretary of the Interior as contributing to the historic significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district; orf

C. Individually listed on a state or city inventory of historic places pursuant to a historic preservation program that has been certified by the Secretary of the Interior or by an approved state program that has been certified by the Secretary of the Interior.

(Ord. 2370 §12)

16.35.070 Mean sea level.

The term “mean sea level” means the National Geodetic Vertical Datum (NGVD) of 1929 or other datum to which base flood elevations shown on a community’s Flood Insurance Rate Map are referenced.

(Ord. 2131 §5)

16.35.075 Non-urbanized area.

"Non-urbanized area" means a developed area or an area outside a developed area in which there are fewer than 10,000 residents (Government Code Section 65007(f).

(Ord. 2131 §5)

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16.35.080 Special flood hazard area.

The term “special flood hazard area” or “area of special flood hazards” means an area having special flood hazards and described or depicted on a Flood Insurance Rate Map prepared and/or approved by the Federal Emergency Management Agency or Federal Insurance Administration as Zones A, AO, A1-A30, AE, A99 or AH.

(Ord. 2131 §5)

16.35.090 Structure.

The term “structure” means a walled and roofed building that is principally above ground. The term “structure” includes a gas or liquid storage tank or a manufactured home.

(Ord. 2131 §5)

16.35.092 Urban area.

"Urban Area" is defined as a developed area in which there are 10,000 residents or more (Government Code Section 65007(l).

(Ord. 2131 §5)

16.35.094 Urbanizing area.

"Urban Level of Flood Protection" means the level of protection that is necessary to withstand flooding that has a 1-in-200 chance of occurring in any given year using criteria consistent with, or developed by, the Department of Water Resources. Urban Level of Flooding shall not mean shallow flooding or flooding from local drainage that meets the criteria of the national Federal Emergency Management Agency standard of flood protection.

(Ord. 2131 §5)

16.35.096 Urban Level of Flood Protection.

"Urban Level of Flood Protection" means the level of protection that is necessary to withstand flooding that has a 1-in-200 chance of occurring in any given year using criteria consistent with, or developed by, the Department of Water Resources. Urban Level of Flooding shall not mean shallow flooding or flooding from local drainage that meets the criteria of the national Federal Emergency Management Agency standard of flood protection.

(Ord. 2131 §5)

16.35.100 Watercourse.

The term "watercourse" means a lake, river, creek, stream, wash, arroyo, channel or other topographic feature on or over which waters flow at least periodically. Watercourse includes specifically designated areas in which substantial flood damage may occur.

(Ord. 2131 §5)

16.35.110 Violation.

The term "violation" means the failure of a structure to be fully compliant with this title and title 16.R of this Code. A structure or other development without the elevation certificate, other certifications, or other evidence of compliance required by this title, or title 16R, is presumed to be in violation until such time as all such documentation is provided.

(Ord. 2370 §13)

16.36 Floodplain Maps, Records and Reports

16.36.010 Approved floodplain maps and reports to be maintained on file in the office of the building division.

The areas of special flood hazard identified by the Federal Emergency Management Agency in the flood insurance map study for the City of Chico and accompanying flood insurance rate maps and flood boundary and floodway maps dated June 8, 1998, and all subsequent amendments and revisions shall be deemed to be incorporated herein.

The building official shall maintain on file in the office of the building official one or more current copies of the flood insurance map study, flood insurance rate map and such other approved floodplain maps and reports as may be provided by the Federal Emergency Management Agency or the Federal Insurance Administration delineating both the areas of special flood hazards and risk premium zones within the city which shall be made available to members of the general public for inspection, review and copying.

(Ord. 2131 §6, Ord. 2370 §14)

16.36.020 Determination of floodplain boundaries and elevations from approved floodplain maps and reports.

The building official shall determine the exact location of floodplain boundaries and elevations from the Flood Insurance Rate Map and other approved floodplain maps and reports provided by the Federal Emergency Management Agency and Federal Insurance Administration and on file in the office of the building division. However, where the exact location of floodplain boundaries or elevations cannot be determined from such map, for example, where there appears to be a conflict between the map and actual field conditions, the building official shall make such determinations from the best available evidence.

(Ord. 2131 §6)

16.36.030 Determination of floodplain boundaries and elevations in absence of approved floodplain maps and reports.

In the absence of a Flood Insurance Rate Map or other approved floodplain map or report provided or approved by the Federal Emergency Management Agency or Federal Insurance Administration, the building official shall determine the exact location of floodplain boundaries and elevations from any base flood elevation and floodway data available from any other federal agency, state agency or reliable source.

(Ord. 2131 §6)

16.36.040 Documentation of floodplain development.

The building official shall maintain on file in the office of the building division copies of the following documents evidencing the location and type of floodplain development, all of which are to be made available to members of the general public for inspection, review and copying:

A. All elevation certificates filed with the building official in the manner required by the floodplain standards adopted by or pursuant to Section 16.37.100 of this title; and

B. All notices of a variance from the floodplain standards adopted by or pursuant to this title.

(Ord. 2131 §6)

16.36.050 Relocation or alteration of a watercourse.

In the event the city proposes to cause or permit the relocation or alteration of a watercourse, the director shall serve the California Department of Water Resources, the County of Butte and any adjoining communities with a notice of such relocation or alteration, and shall provide evidence of such notification to the Federal Emergency Management Agency and Federal Insurance Administration.

In addition, in the event the city proposes to cause or permit the relocation or alteration of a watercourse, the director shall assure that the flood carrying capacity within the altered or relocated watercourse shall be maintained.

(Ord. 2131 §6, Ord. 2364 §331)

16.37 Standards

16.37.010 General provisions.

Except as otherwise provided in this chapter, no person shall cause or permit any development on property within a special flood hazard area of the city which fails to comply with or which violates the floodplain standards adopted by or pursuant to this chapter.

(Ord. 2131 §7)

16.37.020 Adopted standards.

The floodplain standards now or hereafter adopted in Chapter 16R.37 of this code shall constitute the floodplain standards of the city.

(Ord. 2131 §7)

16.37.030 Exemptions from adopted standards.

The following development shall be exempt from compliance with the floodplain standards adopted by or pursuant to this chapter notwithstanding the fact that such development occurs within a special flood hazard area of the city:

A. Any improvement of an existing structure to correct existing violations of any state or local health, sanitary or safety code specifications which have been identified by the city code enforcement officer and which are the minimum necessary to assure safe living conditions; and

B. Any alteration of an historic structure, provided that the alteration will not preclude the structure's continued designation as an historic structure.

(Ord. 2131 §7, Ord. 2370 §15)

16.37.040 Variance from adopted standards - Application for variance.

Any person proposing to develop property within a special flood hazard area of the city who seeks a variance from the floodplain standards adopted by or pursuant to this chapter shall file an application for such variance in the offices of the building official. Such application shall be in the form and contain all of the information required by the building official, and shall be accompanied by an application fee in an amount established by resolution of the city council.

(Ord. 2131 §7, Ord. 2370 §16)

16.37.050 Variance from adopted standards - Findings required to grant variance.

A. Where an application has been filed for a variance from the floodplain standards adopted by or pursuant to this title, the building official shall approve the application and grant the variance if and only if the building official finds that:

1. The property which is the subject of the variance application has physical characteristics so unusual that complying with such standards would create an

exceptional hardship, either to the owner of such property or to the owners of surrounding property;

2. Such physical characteristics are unique to such property and pertain to the land itself, not to the owner of the property, the inhabitants of the property, or any building, structure or other development located on the property;

3. The variance from the floodplain standards is the minimum necessary to afford relief in light of the flood hazards threatening the property; and

4. The variance is otherwise consistent with the purposes of the floodplain regulations and floodplain standards adopted by or pursuant to this chapter.

B. In determining whether a variance for development proposed on property within a special flood hazard area is consistent with the purposes of the floodplain regulations and floodplain standards adopted by or pursuant to this chapter, the building official shall consider all of the following technical factors:

1. The danger that materials may be swept onto other lands to the injury of others;

2. The danger of life and property due to flooding or erosion damage;

3. The susceptibility of the proposed development, or the contents of any building or structure constructed or installed as part of such development to flood damage;

4. The importance of any services to be provided to the community as a result of the proposed development;

5. The availability of alternative locations for the proposed development which are not subject to flooding or erosion damage;

6. The compatibility of the proposed development with existing and other anticipated development;

7. The relationship of the proposed development to the comprehensive plan and floodplain management program for the area;

8. The safety of access to the proposed development in time of flood for ordinary and emergency vehicles;

9. The expected heights, velocity, duration, rate of rise, and sediment transport of the flood waters expected at the site of the proposed development; and

10. The cost of providing government services during and after flood conditions, including maintenance and repair of public utilities and facilities such as sewer, water, gas and electric systems, streets and bridges.

(Ord. 2131 §7)

16.37.060 Variance from adopted standards - Additional factors to be considered in determining whether to grant variance.

A. Generally, variances may be granted by the building official for buildings, structures or other development to be constructed, installed or placed on a lot or parcel which is one-half acre or less in size and which is surrounded by other lots or parcels with existing buildings or structures constructed below the base flood level. As the size of the lot or parcel increases beyond one-half acre, the technical justification required to grant a variance, as set forth in subpart B of Section 16.37.050 of this chapter, shall similarly increase.

B. A variance shall not be granted by the building official for buildings, structures or other development within a floodway if it would result in any increase in flood levels during a base flood.

(Ord. 2131 §7)

16.37.070 Variance from adopted standards - Conditions of approval.

If, when considering an application for a variance from the floodplain standards adopted by or pursuant to this chapter, the building official determines that all of the findings could be made that are required to approve the application and grant the variance provided certain conditions acceptable to the applicant were placed on approval of such variance, the building official shall approve the application and grant the variance subject to such conditions of approval.

(Ord. 2131 §7, Ord. 2268)

16.37.080 Variance from adopted standards - Notice of determination on variance.

A. Where, after considering an application for a variance from the floodplain regulations adopted by or pursuant to this title, the building official determines to approve the application and grant the variance, the building official shall cause a notice of such determination to be served on the applicant and to be included in any file maintained by the building official for the property which is the subject of such application. In such notice, the building official shall set forth the following:

1. A statement of the factual basis for all of the findings required by this chapter to approve such variance;

2. A statement of all conditions of approval, if any;

3. A statement that the variance will result in increased premium rates for flood insurance; and

4. A statement that development below the base flood level increases risk to life and property.

B. Where, after considering an application for a variance from the floodplain standards adopted by or pursuant to this title, the building official determines to deny the application, the building official shall cause a notice of such determination to be served on the applicant. In such notice, the building official shall set forth a statement of the particular findings relied on by the building official in denying such application, as well as the factual basis for such findings, and a statement of the right of the applicant to seek administrative review and appeal the determination in the manner hereinbefore provided in the floodplain regulations adopted by this title.

(Ord. 2131 §7, Ord. 2370 §17)

16.37.090 Inspections of development on property within special flood hazard areas.

Where the building official has reasonable cause to believe that work is being performed on a building, structure or other development within a special flood hazard area of the city in violation of the floodplain standards adopted by or pursuant to this chapter, the building official is authorized to make any inspections of such work necessary to ascertain whether such violation has, in fact, occurred.

(Ord. 2131 §7)

16.37.100 Certificate evidencing compliance with elevation requirements in adopted standards.

Where the floodplain standards adopted by or pursuant to this title require a licensed architect or registered civil engineer to inspect development occurring within a special flood hazard area in order to verify that such development complies with the elevation requirements in the floodplain standards adopted by or pursuant to this title, a certificate evidencing such compliance executed by such architect or engineer shall be filed with the building official on or before completion of such development. If such development includes the construction or installation of a building or structure, or work on any other development requiring a basic building permit or a building service equipment permit issued in the manner required by the building regulations adopted by this title, the building official shall not issue a certificate of occupancy for such building, structure or other development unless and until a certificate evidencing compliance with such elevation requirements has been filed with the building official in the manner required by this section.

(Ord. 2131 §7)

16.37.110 Conflicting laws and regulations.

Where there is a conflict between the floodplain standards adopted by or pursuant to this chapter and the standards in any applicable federal or state law, that standard which provides the most protection for life and property and the environment, as determined by the building official, shall govern; provided that, where there is a conflict between the floodplain standards adopted by this chapter and the standards in any applicable federal or state law or regulation and such federal or state law or regulation expressly preempts local standards which apply to or govern the same subject matter, the standards in the federal or state law or regulation shall govern to the exclusion of the standards adopted by this chapter.

(Ord. 2131 §7)

16.37R Floodplain Standards

16R.37.010 General provisions.

The floodplain standards set forth in this chapter shall constitute the floodplain standards of the city and shall apply to all development occurring within a special flood hazard area of the city in accordance with the provisions of Section 16.37.010 of this code.

(Res. No. 124 96-97)

16R.37.020 Findings.

In accordance with the provisions of Section 17958.5 of the Health and Safety Code, the city council finds that all of the floodplain standards set forth in this chapter which add to or are more restrictive than the standards set forth in Section 16R.02.010 of this code are required by local topographical conditions. In particular, the city council finds that the floodplain standards set forth in this chapter are applicable only to buildings, structures, manufactured homes and other development, or subdivisions that would proposed new such buildings, on property located within a special flood hazard area or area of moderate flood hazard ~~or subdivisions that would proposed new such buildings~~, that such property is situated at an elevation below the base flood level, that because such property is situated below the base flood level, it is subject to periodic inundation by flood waters, and that the flood standards set forth in this chapter are necessary in order to ensure that development is properly elevated, floodproofed and otherwise protected from flood damage, and in order to prevent such development from creating obstructions which cause or contribute to an increase in flood heights and velocities.

Required findings. Under California Government Code section 65962, if a proposed project is located within a flood hazard zone, the City may not approve 1) a Development Agreement; 2) a discretionary permit or other ~~descritionary~~discretionary entitlement that would result in the construction of a new building or construction that would result in an increase in allowed occupancy for an existing building; 3) a ministerial permit that would result in the construction of a new residence; 4) a tentative map, or a parcel map for which a tentative map was not required; unless the City finds, based on substantial evidence in the record, one of the following:

A. The facilities of the State Plan of Flood Control or other flood management facilities protect the project to the urban level of flood protection in urban or urbanizing areas; or, the national Federal Emergency Management Agency (FEMA) standard of flood protection in non-urbanized areas.

B. The City has imposed conditions on the permit or entitlement that will protect the project to the urban level of flood protection in urban and urbanizing area; or, the national Federal Emergency Management Agency (FEMA) standard of flood protection in non-urbanized areas.

C. If the property is intended to be protected by project levees, the City has made adequate progress on the construction of as flood protection system which will result in flood protection equal to or greater than the urban level of flood protection in urban and urbanizing areas; or, the national Federal Emergency Management Agency (FEMA) standard of flood protection in non-urbanized areas the urban level of flood protection shall be achieved by 2025.

D. The City has imposed conditions on the permit or entitlement that will protect the project to the National FEMA Standard of Flood Protection in an urban or urbanizing area where the project is subject to shallow flooding or local drainage.

(Res. No. 124 96-97, Res. No. 139-07, XXX)

16R.37.025 Compliance.

No new construction, or substantial improvement of a structure or other development that would require a building or grading permit pursuant to the applicable provisions of the California Building Code as adopted and modified in Title 9 of the Code shall take place in an area of special flood hazard without full compliance with the terms of this chapter and other applicable flood control regulations. Violation of the requirements (including violations of conditions and safeguards established in connection with conditions) shall constitute an infraction. Nothing herein shall prevent the City from taking such lawful action as is necessary to prevent or remedy any violation.

16R.37.030 Definitions.

The definitions set forth in Chapter 16.35 of this code and the following additional definitions set forth in this section shall govern the construction of the words and phrases contained in the floodplain standards adopted in this chapter.

A. Basement. The term “basement” means any area of the building having its floor subgrade on all sides.

B. Encroachment. The term “encroachment” means the advancement or infringement of uses, plant growth, fill, excavation, buildings, permanent structures or development into a floodplain which may impede or alter the flow capacity of a floodplain.

C. Existing Manufactured Home Park. The term “existing manufactured home park” means a manufactured home park for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including, at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads) is completed before the effective date of the floodplain standards adopted by this chapter.

D. Expansion to an Existing Manufactured Home Park. The term “expansion to an existing manufactured home park” means the preparation of additional sites by the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads).

E. Floodproofing. The term “floodproofing” means any combination of structural and nonstructural additions, changes or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures, and their contents.

F. Highest Adjacent Grade. The term “highest adjacent grade” means the highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.

G. Lowest Floor. The term “lowest floor” means the lowest floor of the lowest enclosed area, including a basement. An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement is not considered a building's lowest floor, provided that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of this chapter.

H. Manufactured Home. The term “manufactured home” means a structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when attached to the required utilities. The term “manufactured home” does not include a “recreational vehicle.”

I. New Construction. The term “new construction” means structures for which the “start of construction” commenced on or after the effective date of floodplain standards adopted by this chapter, and includes any subsequent improvements to such structures.

J. New Manufactured Home Park. The term “new manufactured home park” means a manufactured home park for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads) is completed on or after the effective date of floodplain standards adopted by this chapter.

K. Obstruction. The term “obstruction” includes, but is not limited to, any dam, wall, wharf, embankment, levee, dike, pile, abutment, protection, excavation, channelization, bridge, conduit, culvert, building, wire, fence, rock, gravel, refuse, fill, structure, vegetation or other material in, along, across or projecting into any watercourse which may alter, impede, retard or change the direction and/or velocity of the flow of water, or due to its location, its propensity to snare or collect debris carried by the flow of water, or its likelihood of being carried downstream.

L. Recreational Vehicle. The term “recreational vehicle” means a vehicle which is built on a single chassis; 400 square feet or less when measured at the largest horizontal projection; designed to be self-propelled or permanently towable by a light-duty truck; and designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational, camping, travel, or seasonal use.

M. Start of Construction. The term “start of construction” includes substantial improvement and other proposed new development and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, rehabilitation, addition, placement, or other improvement was within 180 days from the date of the permit. The actual start means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation; or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading, and filling; nor does it include the installation of streets and/or walkways; nor does it include excavation for a basement, footings, piers, or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure. For a substantial improvement, the actual start of construction means the first alteration of any wall, ceiling, floor, or other structural part of a building, whether or not that alteration affects the external dimensions of the building.

N. Substantial Damage. The term “substantial damage” means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

O. Substantial Improvement. The term “substantial improvement” means any reconstruction, rehabilitation, addition, or other proposed new development of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the “start of construction” of the improvement. This term includes structures which have incurred “substantial damage,” regardless of the actual repair work performed.

P. Water Surface Elevation. The term “water surface elevation” means the height, in relation to the National Geodetic Vertical Datum (NGVD) of 1929, (or other datum, where specified) of floods of various magnitudes and frequencies in the floodplains of coastal and riverine areas.

(Res. No. 124 96-97)

16R.37.040 Standards of construction - Anchoring.

All new construction and substantial improvements shall be adequately anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy. All manufactured homes shall meet the anchoring standards of Section 16R.37.080.

(Res. No. 124 96-97)

16R.37.050 Standards of construction - Construction materials and methods.

All new construction and substantial improvement shall be constructed:

A. With materials and utility equipment resistant to flood damage;

B. Using methods and practices that minimize flood damage;

C. With electrical, heating, ventilation, plumbing and air conditioning equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding; and if

D. Within zones designated as AH or AO on the approved floodplain maps on file in the office of the building division, so that there are adequate drainage paths around structures on slopes to guide flood waters around and away from proposed structures.

(Res. No. 124 96-97)

16R.37.060   Standards of construction - Elevation and floodproofing.

A. Residential construction, new or substantial improvement, shall have the lowest floor, including basement:

1. Within a zone designated as AO on the approved floodplain maps on file in the office of the building division, elevated above the highest adjacent grade to a height equal to or exceeding the one foot above the depth number specified in feet on the flood insurance rate map, or elevated at least two feet above the highest adjacent grade if no depth number is specified.

2. Within a zone designated as A on the approved floodplain maps on file in the office of the building division, elevated to ~~or~~ at least one foot above the base flood elevation, as determined by the building official.

3. In all other zones, elevated to ~~or~~ at least one foot above the base flood elevation.

Upon completion of the structure, the elevation of the lowest floor including basement shall be certified by a licensed architect or registered civil engineer, and verified by the building official to be properly elevated.

B. Nonresidential construction, new or substantial improvement, shall either be elevated to conform with Section 16R.37.060-A of this chapter or together with attendant utility and sanitary facilities:

1. Be floodproofed below the elevation required by Section 16R.37.060-A of this chapter so that the structure is watertight with walls substantially impermeable to the passage of water;

2. Have structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy; and

3. Be certified by a licensed architect or registered civil engineer that the standards of this section have been satisfied. Such certification shall be provided to the building official.

C. All new construction and substantial improvement with fully enclosed areas below the lowest floor, excluding basements, that are usable solely for parking of vehicles, building access or storage, and which are subject to flooding, shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwater. Designs for meeting this requirement must exceed the following minimum criteria:

1. Be certified by a licensed architect or registered civil engineer; or

2. Have a minimum of two openings having a total net area of not less than one square inch for every foot of enclosed area subject to flooding. The bottom of all openings shall be no higher than one foot above grade. Openings may be equipped

Commented [HO1]: Many communities use the at least one foot above standard. Some communities even use a standard of at least two feet. It is recommended that the City adopt a higher standard to reduce flood damage risk.

with screens, louvers, valves or other coverings or devices provided that they permit the automatic entry and exit of floodwater.

D. Manufactured homes shall also meet the standards in Section 16R.37.080 of this chapter.

(Res. No. 124 96-97)

16R.37.070 Standards for utilities.

A. All new and replacement water supply and sanitary sewage systems shall be designed to minimize or eliminate:

1. Infiltration of flood waters into the system; and

2. Discharge from the systems into flood waters.

B. Onsite waste disposal systems shall be located to avoid impairment to them, or contamination from them during flooding.

(Res. No. 124 96-97)

16R.37.080 Standards for manufactured homes.

A. All manufactured homes that are placed or substantially improved, within Zones A1- 30, AH, and AE on the approved floodplain maps on file in the office of the building division, on sites located:

1. outside of a manufactured home park,

2. in a new manufactured home park,

3. in an expansion to an existing manufactured home park, or

4. in an existing manufactured home park on a site upon which a manufactured home has incurred "substantial damage" as the result of a flood, shall be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated to or above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation collapse and lateral movement.

B. All manufactured homes to be placed or substantially improved on sites in an existing manufactured home park within Zones A1-30, AH, or AE on the approved floodplain maps on file in the office of the building division that are not subject to the provisions of Section 16R.37.080-A of this chapter will be elevated so that either the:

1. Lowest floor of the manufactured home is at ~~or~~ least one foot above the base flood elevation, or

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2. Manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above grade and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

(Res. No. 124 96-97)

16R.37.090 Standards for recreational vehicles.

All recreational vehicles placed on sites within Zones A1-30, AH, and AE on the approved floodplain maps on file in the office of the building division will either:

A. Be on the site for fewer than 180 consecutive days,

B. Be fully licensed and ready for highway use – a recreational vehicle is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick disconnect type utilities and security devices, and has no permanently attached additions, or

C. Meet the elevation and anchoring requirements for manufactured homes in Sections 16R.37.060 and 16R.37.080 of this chapter.

(Res. No. 124 96-97)

16R.37.095 Standards for subdivisions.

A. All preliminary subdivision proposals shall identify the flood hazard area and the base flood elevation. The documents shall clearly indicate the Lowest Adjacent Grade and the Highest Adjacent Grade prior to the alteration of the existing topography before grading (cut or fill).

B. All final subdivision plans will provide the lowest floor elevation of proposed structures and pads. If the site is filled above the base flood, the final pad elevation shall be certified by a registered professional engineer and provided to the Floodplain Administrator and a Letter of Map Revision will be submitted to FEMA.

C. All subdivision proposals shall be consistent with the need to minimize flood damage.

D. All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize flood damage.

E. All subdivisions shall provide adequate drainage to reduce exposure to flood hazards.

(Res. No. 124 96-97)

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16R.37.100 Floodways.

The approved floodplain maps on file in the office of the building division may designate certain flood hazardous areas as floodways. Such floodways are extremely hazardous due to the velocity of flood waters which carry debris, potential projectiles, and erosion potential. Within such floodways, the following provisions apply:

A. Prohibit encroachments including fill, new construction, substantial improvement, and other new development unless certification by a licensed architect or registered civil engineer is provided demonstrating that such encroachments shall not result in any increase in the base flood elevation during the occurrence of the base flood discharge.

B. If subpart A of this section is satisfied, all new construction, substantial improvement, and other proposed new development shall comply with all other applicable flood hazard reduction provisions of this chapter.

(Res. No. 124 96-97)

16.38 Enforcement

16.38.010 General provisions.

The floodplain regulations adopted by this title may, upon any violation thereof, be enforced by the enforcement actions and penalties provided for in this chapter. Except as otherwise specifically set forth in this chapter, all enforcement actions and penalties provided for herein shall be deemed cumulative, and the commencement and/or imposition of any one such enforcement action or penalty as a result of a violation of the floodplain regulations adopted by this title shall not preclude commencement and/or imposition of any other enforcement action or penalty for the same violation.

(Ord. 2131 §8)

16.38.020 Request to correct violation.

A. Determination by Building Official to Request Correction of a Violation. Whenever the building official determines that floodplain work is being performed or a condition exists in violation of the floodplain regulations adopted by this title, the building official may, by service of a notice provided for by this section, request such violation to be corrected.

B. Service of Notice Requesting Correction of a Violation. Upon determining to request a correction of a violation of the floodplain regulations adopted by this title, the building official shall cause a written notice of such request to be served on the owner of the property on which the violation has occurred, and on any other person known to the building official to be wholly or partially responsible for such violation if such person is someone other than the owner of the property on which the violation has occurred. Such notice shall contain a brief description of the nature of the violation, the action to be taken to correct the violation, and a date certain by which the corrective action must be completed; shall contain a statement of the right of a person aggrieved by the determination of the building official that a violation has occurred to apply for administrative review of such determination and to appeal such determination in the manner provided for by Chapter 16.34 of this title; and shall advise the person upon whom the notice is served that a failure to correct the violation on or before the date required by the notice may subject such person to the infraction penalties provided for in Section 16.38.060 of this chapter.

C. Effect of a Request to Correct Violation. Any person served with a request of the building official to correct a violation of the floodplain regulations adopted by this title shall cause such violation to be corrected on or before the date required by such notice. Provided, however, that if a person is served with a notice to correct a violation, such person shall not be subject to any of the infraction penalties provided for in

Section 16.38.060 of this chapter unless such person fails to correct such violation on or before the date required by such notice.

(Ord. 2131 §8)

16.38.030 Order to stop work.

A. Determination of the Building Official to Order Work to be Stopped. Whenever the building official determines that floodplain work is being performed in violation of the floodplain regulations adopted by this title, the building official may, by service and posting of the notices required by this section, order such work to be stopped.

B. Service of Notice of Order to Stop Work. Upon determining to order floodplain work to be stopped, the building official shall cause a written notice of such order to be served on the owner of the property on which such work is being performed, and on any person known to the building official to be engaged in the work if such person is someone other than the owner of the property on or within which the work is being performed. In addition to setting forth the order of the building official to stop floodplain work, such notice shall contain a brief description of the reasons why such work is being ordered stopped and the action, if any, which may be taken in order that the work may be resumed; shall contain a statement of the right of a person aggrieved by such order to apply for administrative review of the order and to appeal the order in a manner provided for by Chapter 16.34 of this title; and shall advise the person on whom the notice is served that unless authorized by the building official, any further work on such floodplain may subject such person to the misdemeanor penalties provided for in Section 16.38.060 of this chapter.

C. Posting of Notice of Order to Stop Work. Upon determining to order floodplain work to be stopped, the building official shall also cause a written notice of such order to be posted in a conspicuous place on the property on which floodplain work is being performed. In addition to setting forth the order of the building official to stop floodplain work, such notice shall state that it is a misdemeanor for any person to perform any further floodplain work without authorization of the building official or to remove or deface the posted notice of such order.

D. Effect of an Order to Stop Floodplain Work. No person served with a notice of the building official's order to stop floodplain work shall cause or permit such work to be performed.

(Ord. 2131 §8)

16.38.040 Right of entry.

Whenever necessary to enforce the floodplain regulations adopted by this title, the building official may enter upon any property located within the city at a reasonable time to inspect such property and any floodplain work being performed thereon; provided that, if such property is occupied, the building official shall first present proper credentials to the occupant thereof and demand entry; and if such property is not occupied, the building official shall first make a reasonable effort to locate the owner or other person having charge or control of the property and demand entry. Should entry be refused, the building official shall have recourse to every remedy provided by this code and the laws of the state of California to secure same.

(Ord. 2131 §8)

16.38.050 Violation declared a public nuisance.

Any floodplain work performed in violation of the floodplain regulations adopted by this title shall be and is declared to be a public nuisance, and the city attorney is authorized to commence an action or proceed in a court of appropriate jurisdiction to abate such nuisance in the manner provided for by law.

(Ord. 2131 §8)

16.38.060 Penalties.

A violation of the floodplain regulations adopted by this title shall be an infraction which is punishable by a fine in an amount provided by Section 1505 of the Charter of the City of Chico; except that a violation of any order to stop work and/or the removal or defacement of any notice of such order posted by the building official in the manner provided for by this chapter shall be a misdemeanor punishable by imprisonment in the county jail for a period not exceeding six months, or by a fine not exceeding $1,000, or by both.

(Ord. 2131 §8, Ord. 2136 §8)

City of Chico

Storm Water Master Plan

Appendix A.3 – Storm Drainage

City of Chico Code of Ordinances

Chapter 18R.08.050 – Storm Drainage

A. General Requirements. The subdivider shall provide storm drainage facilities that will convey stormwater runoff, whether originating within the subdivision or in adjacent areas, to an existing drainage channel or drainage system. Adequate access for maintenance of the system shall be provided. The capacity of an existing drainage system must be large enough to accommodate the additional runoff generated by the subdivision. Drainage patterns existing prior to construction of the subdivision shall be maintained, and full consideration must be given to the rights of adjacent property owners with regard to surface water drainage.

The city will determine the capacity of an existing storm drain system.

The subdivider's engineer shall prepare an analysis and design of the proposed storm drainage system. When stage construction is proposed, the analysis shall provide for the design of the entire storm drainage system.

The analysis shall consider all existing and future contributory drainage area, regardless of whether or not said area is in the subdivision.

The preliminary analysis shall accompany the tentative map.

B. Hydrology.

1. Storm Runoff. Runoff shall be computed by the rational method or alternative methodology approved by the City. Approved hydrograph methods shall be used for volumetric flow routing. The Rational Method is appropriate for peak flow analysis that does not require volumetric flow routing, and is defined by the formula:

~~(~~Q = CIA~~)~~ where:

Q = rate of runoff in cfs

C = coefficient of runoff

I = average intensity of rainfall in inches/hour during the time of concentration, tc, (minutes~~.~~). ~~—~~The time of concentration is the ~~elapsed time between the beginning of the~~flow travel time from the most remote point in the area tributary to a point of interest to that point of interest~~ storm and peak flow at the drainage structure~~. A typical point of interest would be an inlet to a drainage system.

A = drainage area, acres

Computations should be clear and complete with all assumptions clearly stated. In making such computations, the following information shall be used:

a. Coefficient of Runoff. Typical values for runoff coefficients are set forth in Table 3. Runoff coefficients for drainage system design shall not be less than the area weighted average of 0.2 for pervious areas and 0.9 for impervious areas. Runoff coefficients for storm water quality treatment systems shall be computed in accordance with the Post-Construction Standard Plans.

b. Intensity of Rainfall. A rainfall intensity versus duration design chart for the Chico area is shown on Table 4. A minimum time of concentration of 10 minutes should

Commented [HO1]: Recommendations for updating precipitation will be provided as part of the SWMP, but are not available yet.

be used whenever computations indicate a shorter time. For urban area drainage, the maximum initial time of concentration to the first drainage facility shall be 20 minutes. For unimproved areas, drainage time of concentration shall be determined by the method ~~shown for small basins~~ in the Caltrans Highway Design Manual Section 816.6. The method of computation of time of concentration should be clearly indicated.

c. Design Storm Frequency. The design storm frequency shall be as follows:

Commented [HO2]: Recommendations for this subsection will be developed as the SWMP progresses.

(1) Bridges, 200 years;

Commented [HO3]: Because this is addressing Bridges with a 200-year requirement, should it also address levees? What about a small bridge over a minor channel?

(2) Open channels, 10 years;

(3) Culverts, 10 years;

(4) Major outfall lines, 10 years;

(5) Collector lines, 5 years;

(6) Local lines, 2 years.

Commented [HO4]: How are these defined?

A minimum freeboard of three feet shall be provided for bridges and box culverts, two feet for open channels, and one foot for storm drainage pipe inlets and outlets.

Commented [HO5]: How is freeboard defined? To the minimum low chord?

Commented [HO6]: Freeboard to what?

C. Roadway Drainage.

1. Grade. The minimum grade for side ditches and gutters will be 0.25% if paved, 0.50% if earth.

2. Limits of Flooding. Street drainage facilities shall be designed to keep flooding within six (6) feet of the face of curb for a design storm frequency of two (2) years for local streets and ten (10) years for all other streets. The depth of flow at gutter flow line shall not exceed 0.25 feet for the design storm frequency.

Concentrated flow across the traveled way is prohibited.

D. Conduit Design.

1. Type. For storm drain systems, circular pipes of reinforced concrete or cast-in-place concrete may be used. Class II pipe shall be the minimum for nonroadway areas. The minimum required strength for all pipe in the roadway area shall be Class III as designated by ASTM Specification C-76.

Culverts may be of any of the above materials in any standard manufactured shape. Reinforced concrete box culverts, if used shall be constructed in accordance with state standard plans.

2. Size. Pipes shall have a minimum diameter of 10 inches. For flows exceeding the capacity of 54-inch diameter pipe, open channels meeting the requirements of subsection H below may be acceptable.

Commented [HO7]: 12 inch minimum for laterals and 15 or 18 inch minimum for trunk lines is more typical for current municipal standards.

3. Slope. Slope will be controlled by physical conditions and velocity criteria. Abrupt changes in slope are undesirable and are to be avoided wherever possible.

4. Velocity. Minimum velocity at full flow shall be two (2) feet per second (fps). The maximum velocity for storm drains shall be ~~critical velocity at full flow~~10 feet per second at the design flow rate. Froude numbers between 0.8 and 1.2 at design flow conditions should be avoided. Culverts may have velocities greater than ~~critical~~ 10 feet per second provided full consideration is given to the effects of abrasion and energy dissipation.

5. Head and Head Losses. To facilitate the passage of debris and detritus, storm drains shall, unless otherwise approved, be designed to pass the design flow with a free water surface. Culverts shall be designed to provide a minimum freeboard of one foot from top of culvert to top of ditch bank at the entrance and exit points.

Commented [HO8]: This conflicts with the criteria in B.1.c

6. Roughness Coefficient. Suggested values for Manning's roughness coefficient (n) are:

Reinforced concrete pipe 0.012

Cast-in-place concrete pipe 0.013

7. Alignment. Alignment should be as straight as possible without undue bends and angle points. Where dictated by physical conditions, curved alignment is permissible as long as there is no reduction in the quality and soundness of joints. The minimum radius of curvature shall be 500 feet.

8. Cover. Except for culverts, outside the hinge point, the minimum cover shall be two (2) feet, measured from the top of the pipe to the roadway or ground surface. Cast-in-place concrete pipes shall have a minimum cover of two and one-half (2.5) feet except under roadways where three (3) feet is required. Where less than minimum cover is necessary the concrete cradle shown in the improvement standards shall be used.

9. Pipe Strength. The class of conduit recommended should be adequate for most conditions. Unusual situations may dictate selection of a higher strength conduit.

10. Location. The location of storm drains relative to roadway centerline shall be in accordance with the improvement standards. Care should be taken that storm drains and other underground facilities do not conflict with each other. Location and elevation of existing and proposed sanitary sewer laterals shall be a primary consideration in the design of the storm drainage facility.

E. Drop Inlets.

1. Types. The standard S-7 drop inlet as set forth in the improvement standards shall be used with pipes up to 30 inches in diameter. A modified S-7 drop inlet or a manhole will be used for pipe larger than 30 inches. Special situation drop inlets are shown in Standards S-7A and S-26.

2. Laterals. Laterals shall have a minimum slope 1%.

3. Location. Drop inlets shall be installed at all gutter low points and at locations such that the flooding limitations of subsection C above are met. They should not be spaced further than 500 feet apart.

F. Manholes.

1. Type. The type of manhole to be utilized shall be as set forth in the improvement standards.

2. Location. Manholes shall be placed:

a. Where two or more storm drain pipes join;

b. Where the conduit changes in size;

c. At angle points;

d. At points where a change of slope in the conduit occurs;

e. At changes in type of pipe.

3. Spacing. The maximum manhole spacing shall be 1,200 feet for pipe diameters of 48 inches or more. Spacing may vary from 350 to 700 feet for diameters less than 48 inches to 33 inches. Maximum spacing shall be 350 feet for conduit 30 inches or smaller.

4. Access Shaft. The access shaft shall be centered over the axis of the drain for conduits less than 42 inches in diameter. The shaft shall be offset and made tangent to one side of the pipe when the drain diameter exceeds 42 inches.

5. Special Structures. Special structures may be required for larger diameter pipes and shall be designed on an individual basis.

6. Grade. The crowns of all conduits intersecting at a manhole shall generally match. A minimum fall of 0.10 foot across the manhole shall be provided except in cases where the conduit is continuous through the manhole.

G. End Structures.

1. General. Headwalls and other end structures shall be installed to increase hydraulic efficiency, prevent erosion adjacent to the conduit and provide a counterweight to prevent flotation.

2. Entrances. When a drop inlet is not installed, flared end sections should be used. Headwalls may be used where dictated by physical conditions. Both installations shall conform to the state standard plans.

3. Exits. Where exists are installed, headwalls or flared end sections should be used for culverts. Where drainage systems discharge into a channel, standard headwalls shall be installed in accordance with the improvement standards.

An approved energy dissipater shall be installed at outlets where velocities are erosive.

H. Open Channels. The director may approve the use of open channels on an individual basis.

The finished channel shall have maintenance free bottom and sides. Minimum bottom width shall be three feet. Side slopes shall be no steeper than1-1/2:1.

Commented [HO9]: How is maintenance free defined?

All open channels shall be located in dedicated easements. An access road 12 feet wide shall be provided adjacent to the channel.

Commented [HO10]: On one side, or both? Would this depend on the width of the channel.

I. Bank Protection. Bank protection such as slope paving, sacked riprap, and facing rock may be required to protect drainage facilities, property or structures. The need and nature of bank protection will be determined by the director on an individual basis.

J. Temporary Leach Field Type Storm Drainage System. In accordance with the provisions of the "Nitrate Action Plan - Greater Chico Urban Area - Butte County," adopted by city council Resolution No. 141 84-85 on March 19, 1985 as subsequently amended, temporary leach field type storm drainage systems may be installed for temporary use in cases where the public works director determines that storm water cannot be conveyed to the city's storm drainage system or drainage channel because facilities are not available. The following criteria shall apply to design of such systems:

1. Percolation tests shall be conducted in accordance with environmental health department procedures. Tests shall be taken at the proposed depth of the drainage trench(es) at such locations as required by the public works director to verify the drainage capacity of the soil. Percolation rate shall be converted from minutes/inch to cubic feet per second/square foot using methodology that provides a vertical infiltration rate that considers the test hole configuration and accounts for lateral flow that may be included in the field measurements. A minimum factor of safety of 3 shall be applied to infiltration rates determined using falling head borehole infiltrometer testing procedures. A minimum factor of safety of 2 may be used if double-ring infiltrometer testing is performed at the bottom elevation of the planned infiltration system.

2. The trench(es) shall be designed to contain a one-in-ten-~~-~~year frequency storm.

3. ~~The bottom of the trench(es) shall be at least ten feet above the high water table and there shall be at least ten feet of soil capable of percolation below the bottom of the trench(es).~~Volumetric flow routing using runoff computed using 24-hour precipitation based on NOAA Atlas 14 data and TR-55 loss rate and flow routing or alternative hydrologic methodology approved by the city.

4. ~~The rational formula, Q=CIA, shall be used to determine inflow into trench(es)~~The trench shall be configured to infiltration the maximum stored volume within 24 hours.

5. One-third of the trench(es) volume as void area shall be used in computing amount of storm water storage available in trench(es). Rock size in trench(es) shall be from one-half inch to four inches in size.

6. ~~Fifty percent of the trench(es) bottom area and one-half of the depth of the trench(es) side walls and end walls shall be used in determining the area available for percolation out of the trench(es)~~Systems, such as pipes and arches, that increase the storage in trenches above that provided in drain rock voids may be used if EPA requirements for Class V injection wells are followed.

Commented [HO11]: This would no longer be required as a result of adding a factor of safety and flow routing.

7. Where more than one trench is utilized, there shall be a minimum separation of four (4) feet between trench walls. The total effective infiltration area from the sides of parallel trenches shall not exceed the spacing between trenches.

8. Limitation on Use of Infiltration Best Management Practices (BMPs). Three factors significantly influence the potential for storm water to contaminate ground water. They are: (i) pollutant mobility, (ii) pollutant abundance in storm water, and (iii) soluble fraction of pollutant. In addition, the distance of the groundwater table from the infiltration BMP may also be a factor determining the risk of contamination. A water table distance separation of ten feet in depth in California presumptively poses negligible risk for storm water not associated with industrial activity or high vehicular traffic. Site specific conditions must be evaluated when determining the most appropriate BMP. Additionally, monitoring and maintenance must be provided to ensure groundwater is protected and that the infiltration BMP is not rendered ineffective by overload. This is especially important for infiltration BMPs in areas of industrial activity or areas subject to high vehicular traffic (25,000 or greater average daily traffic (ADT) on a main roadway or 15,000 or more ADT on any intersecting roadway). In some ~~cases~~cases, pretreatment may be necessary.

K. Post-Construction Structural or Treatment Control Best Management Practices. Post- construction treatment control Best Management Practices (BMPs) shall incorporate, at a minimum, either a volumetric or flow based treatment control design standard, or both, as identified below to mitigate (infiltrate, filter or treat) storm water runoff:

1. Volumetric Treatment Control BMPs

a. The maximized capture storm water volume for the tributary area, on the basis of historical rainfall records, determined using the formula and volume capture coefficients in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87 (1998) pages 175-178 (approximately the 85th percentile 24-hour storm runoff event); or

b. The volume of annual runoff to achieve 80 percent or more capture, determined in accordance with the methodology in Section 5 of the CASQA Storm Water Best Management Practice Handbook, New Development and Redevelopment (2003), using local rainfall data; or

2. Flow Based Treatment Control BMPs:

a. The flow of runoff produced from a rain event equal to at least two times the 85th percentile hourly rainfall intensity as determined from local rainfall records; or

b. The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity.

(Res. No. 9 77-78 (part), Res. No. 57 82-83 §5, Res. No. 201 84-85 §1, Res. No. 59 90-91 §§8-10, Res. No. 11 95-96 §1, Res. No. 113-07, Res. No. 65-08, Ord. 2468 §6)

Commented [HO12]: It is recommended that this section be replaced with a reference to **Chapter 15.50 – Storm Water Management and Discharge Controls** for Storm Water Quality requirements.

City of Chico
Storm Water Master Plan
Appendix B – Drainage System Data
(Digital Only, Geodatabase)

Appendix B.1 – GIS Deliverable

Appendix B.2 – Links

Appendix B.3 – Nodes

Appendix B.4 – Watersheds

Appendix B.1 – GIS Deliverable

An ArcGIS Pro Package was completed on May 28, 2024 and delivered to the City. The file is titled "GIS_Deliverable.ppkx." The package contains the project geodatabase and a set of report figures.

The geodatabase contains 112 feature classes, 18 raster layers and 5 tables. Most of the data and sources are described in the report and/or identified on the figures. The table lists the data provided:

Feature Classes
Airport__Polygon
BMP_Interceptors
BO_result_node_20240429
Big_Chico__Polygon
Breach_Locations
Bridges_and_Culverts
Bubble_up_Locations
Building_Polygon
BuildoutNodes
CDEC_Locations
CIP_Analysis_Point
CIP_Areas
CIP_Groupings_V3_20240410
CIP_Groupings_V3_20240410Anno
CVFED_Breach_Locations
CVFED_Breach_Locations_UpperSacSystem
Channel_1D_Polygon
Chico_Breach_Location
Chico_Breach_Relocated
Chico_Zoning_Complete_20230214
Chico_Zoning_Complete_Updated_20230214
Citywide_Link
Citywide_Node
Comanche__Polygon
Conduits_w_City_V3_Model
Creeks_Areal_Reduction_Factor
Cross_sections
Detention_Basins
Development_Areas
DrainageAreaToProposedDevices
Ex_Drain_Inlet_Conditions_20230607
Existing_2D_Point_Source

Feature Classes
FLOW_CHANGE_LOCATION
HEC_RAS_Rivers_V002
HEC_RAS_Rivers_V002Anno
HEC_RAS_Rivers_V002Anno2
ICM_Watersheds_20240405
Infilt_Trench
Infiltration_Trenches
Inline_Structures
InstalledSmallDevices
JensenInterceptors
Lake_Pond
Lateral_Structures
Levee
Little_Chico_Polygon
Lower_Lindo_Existing_Polygon
Mesh_Zone
Model_AreasAnno
New_Det_BasinsAnno
Nodes_20240122
Nodes_EX_Remove_Replace_20231204
Nodes_Proposed_20231202
North_Chico_Area
OverlapWatershedsCount_Outfall
PLU_Treatment
PV_Ditch_Polygon
Parcels
PlannedLargeDevices
Precip_100YR_1HR_Isohyetal
Precip_100YR_24HR_Isohyetal
Precip_10YR_1HR_Isohyetal
Precip_10YR_24HR_Isohyetal
Precip_2YR_1HR_Isohyetal
Precip_2YR_24HR_Isohyetal
Precip_Zones_100YR_24HR
Priority_Landuse_Area_fromCity
Proposed_Basins
Proposed_Devices_20240416
Proposed_Pump
Roads_geocode
Roughness_Zone
SA_2D_Connections

Feature Classes
SD_DEMExtent_CVFED2008
SD_DEMExtent_FEMA2017
SD_DEMExtent_USGSNorCAL2018
SUDAD__Polygon
S_FLD_HAZ_AR
S_LEVEE
S_PROFIL_BASLN
Soil_CA612_Clip
Soils_Group_CA612
South_Sycamore__Polygon
Sphere_of_Influence
StreamsAnno2
Streams_All
Streams_Anno2
Streams_Tributaries_StudyArea
Streets_No_Curb_Gutter_V3
Study_Limits
Surface_BMP
Tributary_parcel_to_BMP
Tributary_parcel_to_Surface_BMP
Underground_Pipe_StorageAnno5
Upper_Lindo_Polygon
Water
Watershed_Flooding_10sqmi
Watershed_StudyArea
Watershed_StudyArea2
WatershedsDrainToMultipleCount_Outfall
Watersheds_BigChico_MudCreek_RockCreek
Watersheds_HUC12
Watersheds_LittleChico_ButteCreek
Watersheds_NHD_Flowline
Watersheds_NHD_Plus_Flowline
a10sqmi
a1_D_HEC_RAS_Channel_Flow_Path
a1_D_Storage_Areas
a2_D_Flow__Area_Breaklines
city_limits
wr_Freeboard_Deficiency_3ft_100year
wr_Freeboard_Deficiency_3ft_200year

Raster Data
IA (Impervious Area)
V015_2D_n_values_20240221_V2
a100YR_MUD_RAS
a100YR_SYC_RAS
a200YR_MUD_RAS
a200YR_SYC_RAS
a500YR_MUD_RAS
a500YR_SYC_RAS
g_100YR_Flooding_from_HecRAS
g_100YR_Flooding_from_HecRAS_V2
g_100YR_Flooding_from_ICM_V2
g_10YR_Flooding_from_HecRAS
g_10YR_Flooding_from_HecRAS_V2
g_10YR_Flooding_from_ICM_V2
g_200YR_Inundation
g_DEM_Mosaic
g_USA_Topo_Maps
g_depth_clip_GT_3in_Final_2year

Tables
Detention_Basins_Statistics1
Proposed_Devices__Statistics
TraceResults_Edit_Statistics
WR_Comments_GIS_
tbl_SoilKsat_CA612

Appendix B.2 – Links

"Link Type" describes different types of links as referenced in the report (see 5.3.1 Table 9 for details).

The field:

"Model Status" indicates which features are modeled and not modeled.

"Shape ID" identifies the modeled shape of conduits (note: Elliptical conduits are modeled as circular with a pipe diameter that provides similar conveyance) the elliptical dimensions can be found in the "WR_Comments" field.

"WR Classification" : "EX" indicates existing feature and "Future" indicates proposed feature.

"WR_Comments" include comments by Wood Rodgers.

"CIP_Group" groups for storm drain improvements based on location. There are twenty-three different project areas defined. The project groupings are presented on Figure 50.

"Asset ID" include unique ID for conduits.

"Number of Barrels"- number of pipes.

"Roughness type" shows Manning's N for conduits

"Height" & "Width" shows pipe dimensions of conduit.

"Manning's n" include roughness coefficients based on pipe material (see 6.3.2 in report for details).

"US headloss coefficient" & "DS headloss coefficient" include junction head loss coefficients (see 6.3.2.1 in report for details).

"Model" shows model name.

"Buildout_Model" indicates which features were included in the buildout conditions models with a "Yes."

"Existing_Model" indicates which features were included in the existing conditions models with a "Yes."

"DivergedSystems" flags the split flows in the storm drain system.

"ProjCat1" through "ProCat5" indicates what category the proposed improvements fall into (see 12.1 in report for details and Figure 52)

"ROW_Needed" shows where drainage improvements are outside the public ROW.

"ROW_Length_Needed" includes length of proposed pipe that intersects parcel (see 11.1.4 in report for details).

Appendix B.3 – Nodes

The Citywide_Node feature class includes different types of nodes.

"Node ID" field shows the unique identifier for each feature

"Node type" field provides the modeled node type as described in Section 6.3.3 of the report

"PhysicalType" field describes the actual type of the feature

"Model Status" indicates which features are modeled and not modeled.

"WR Classification": "EX" indicates existing feature and "Future" indicates proposed feature (see 5.3.2 in report for details).

"WR_Comments" include comments by Wood Rodgers.

"Buildout_Model" indicates which features were included in the buildout conditions models with a "Yes."

"Existing_Model" indicates which features were included in the existing conditions models with a "Yes.

"Model" shows model name.

"CIP_Group" groups for storm drain improvements based on location. There are twenty-three different project areas defined. The project groupings are presented on Figure 50.

"ProjCat1" through "ProCat5" indicates what category the proposed improvements fall into (see 12.1 in report for details and Figure 52)

"HGL_2YR", "HGL_10YR", "HGL_100YR" fields shows maximum HGL at each location

"Max_Volume_2YR", "Max_Volume_10YR","Max_Volume_100YR" fields show the maximum volume at the node.

"GrElev_Volume_2YR", "GrElev_Volume_10YR", "GrElev_Volume_100YR" fields show the volume of node up to ground level (volume at ground level)

"Sum_WatershedAcres" field shows tributary area to each node (NOTE: tributary areas associated with some nodes overlap due to split flow/diversion systems) (see 5.3.4 in report for details and Figure 9)

"Sum_ImperviousAcres_EX" field shows the existing impervious area in acres

"Sum_ImperviousAcres_BO" field shows the buildout impervious area in acres

"SUM_TotalPLUAcres" field show the cumulative PLU area for each node

"AreaRatio" : Cumulative PLU area/ Cumulative watershed area

"CountNodes" field shows total number of nodes upstream of storm drain system

Appendix B.4 – Watersheds

"Subcatchment" field indicates the unique name for watershed

"Model_Name" shows model name/domain

"PassThroughArea" field flags areas where flows pass though an underground storage or a detention basin then get routed to another detention basin

"Drain_Area" field indicates watersheds that drain to a detention basin, which includes the name of detention basin, watersheds that drain to a capped system/infiltration system that is not connected to city's storm drain system, watersheds that drain to a FSC trash capture device, watersheds that drain to an infiltration system that is connected to the city's storm drain system, and watersheds draining to an underground storage system.

"PassThroughBasin" field indicates the name of the detention basin/underground storage where the pass through areas drain to.

Hydrology Parameters:

"Min_Elev" field shows maximum elevation point

"Max_Elev" field shows minimum elevation point

"WTR_Perimeter" field indicates perimeter of watershed

"WTR_PerimeterPerArea"- Perimeter per Area

"WTR_Area" field shows area of the watershed in square feet

"Slope" field shows the slope of each watershed and it was determined by taking the difference between minimum and maximum point elevations in the watershed and dividing this by the length of the Longest Flow Path (LFP) (see 6.2.3.1 in report for details)

"Precip_Zone" field indicates the precipitation zone (see 6.2.1 for details).

"P_2yr_24hr" field indicates the 2-hour and 24-hour precipitation depth

"P_10yr_24hr" field indicates the 10-hour and 24-hour precipitation depth

"P_100yr_24hr" field indicates the 100-hour and 24-hour precipitation depth

"Existing_drains_to" field indicates type of object to which the watershed drains in the existing conditions models

"Existing_Node_ID" field indicates the node to which the watershed drains in the existing conditions models (see 5.3.2 in report for details)

"Existing_2D_point_ID" field indicates the 2D point source to which the watershed drains in the existing conditions models (see 6.3.3.7 in report for details)

"Est_Flow_Length" - Estimated flow length in existing conditions (see 6.2.3.1 in report for details)

"Est_Sheet_Flow_Length" - estimated sheet flow length in existing conditions (see 6.2.3.1 in report for details)

"Conc_ Flow_Path_Length" - concentrated flow path length in existing conditions (see 6.2.3.1 in report for details)

"n_value" - Manning's roughness coefficient in existing conditions (see 6.2.3.1 in report for details)

"EX_Eff_Imperv" - Existing effective imperviousness (see 7.2 in report for details)

"Sheet_Flow_Time" - Sheet flow time in existing conditions (see 6.2.3.1 in report for details)

"Velocity_Paved" - Paved velocity in existing conditions (see 6.2.3.1 in report for details)

"Velocity_Unpaved" - Unpaved velocity in existing conditions (see 6.2.3.1 in report for details)

"Effective_Velocity" - Effective velocity in existing conditions (see 6.2.3.1 in report for details)

"Conc_Flow_Time" - Concentrated flow time in existing conditions (see 6.2.3.1 in report for details)

"Time_of_Concentration" - Time of Concentration in existing conditions (see 6.2.3.1 in report for details)

"LossRate" - Loss Rate in existing conditions (see 6.2.2 in report for details)

"Lag_Time" - Lag time in existing conditions (see 6.2.3.1 in report for details)

"Perc_A" field indicates the percentage pervious area with soil type A in existing conditions

"Perc_B" field indicates the percentage pervious area with soil type B in existing conditions

"Perc_C" field indicates the percentage pervious area with soil type C in existing conditions

"Perc_D" field indicates the percentage pervious area with soil type D in existing conditions

"Buildout_Drains to" field indicates type of object to which the watershed drains in the buildout conditions models

"Buildout_Node ID" field indicates the node to which the watershed drains in the buildout conditions models (see 5.3.2 in report for details).

"Buildout 2D point ID" field indicates the 2D point source to which the watershed drains in the buildout conditions models (see 6.3.3.7 in report for details)

"BO_Est_Flow_Length" - Estimated flow length in buildout conditions (see 6.2.3.1 in report for details)

"BO_Est_Sheet_Flow_Length"- Estimated sheet flow length in buildout conditions (see 6.2.3.1 in report for details)

"BO_Conc_ Flow_Path_Length"- concentrated flow path length in buildout conditions (see 6.2.3.1 in report for details)

"BO_n_value"- Manning's roughness coefficient in buildout conditions (see 6.2.3.1 in report for details)

"BO_EX_Eff_Imperv"-Buildout effective imperviousness

"BO_Sheet_Flow_Time"- Sheet flow time in buildout conditions (see 6.2.3.1 in report for details)

"BO_Velocity_Paved" - Paved velocity in buildout conditions (see 6.2.3.1 in report for details)

"BO_Velocity_Unpaved"- Unpaved velocity in buildout conditions (see 6.2.3.1 in report for details)

"BO_Effective_Velocity" - Effective velocity in buildout conditions (see 6.2.3.1 in report for details)

"BO_Conc_Flow_Time"- Concentrated flow time in buildout conditions (see 6.2.3.1 in report for details)

"BO_Time_of_Concentration"- Time of Concentration in buildout conditions (see 6.2.3.1 in report for details)

"BO_LossRate"- Loss Rate in buildout conditions (see 6.2.2 in report for details)

"BO_Lag_Time"- Lag time in buildout conditions (see 6.2.3.1 in report for details)

"BO_Perc_A" field indicates the percentage pervious area with soil type A in buildout conditions

"BO_Perc_B" field indicates the percentage pervious area with soil type B in buildout conditions

"BO_Perc_C" field indicates the percentage pervious area with soil type C in buildout conditions

"BO_Perc_D" field indicates the percentage pervious area with soil type D in buildout conditions

City of Chico

Storm Water Master Plan

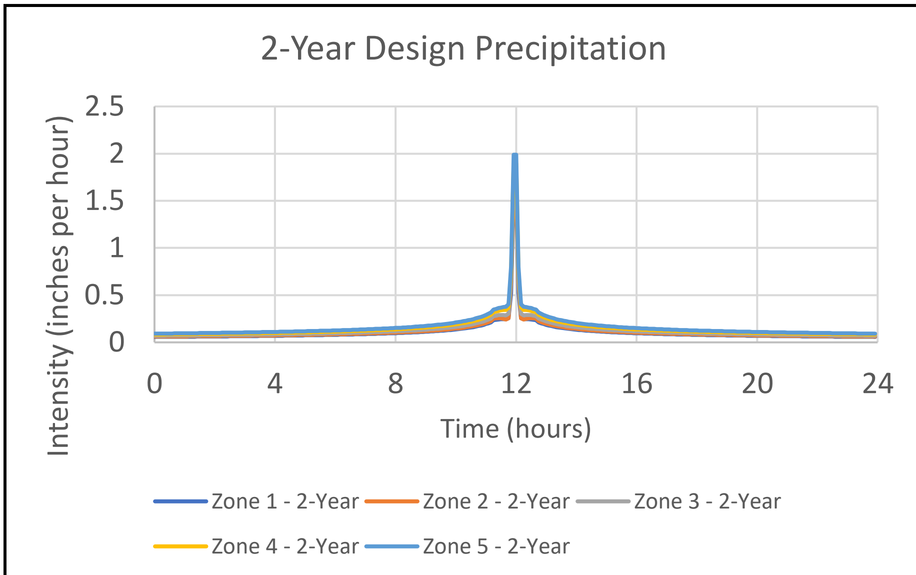
Appendix C – Precipitation Intensity Values

1

Precipitation Depth and Intensity Calculator							
Tc	12.8	minutes	Enter values				
PZ	1						
RI	100	Recurrence interval (years)					
a	b	v	w	x	y	z	
7.6401307	0.471151	21119.82	-7642.13	798.6609	-17.9389	0.110882	
Intensity, i:	3.025	in/hr	Results				
Depth, d:	0.645	in					
Please note that the City has this spreadsheet available for distribution.							

Recurrence Interval (years)	**Variable**		**Precipitation Zone 1**	**2**	**3**	**4**	**5**
2	**a**	**2a**	3.696285	3.902837	4.20058	4.508644	4.65271
2	**b**	**2b**	0.48328	0.482176	0.475709	0.464182	0.456079
2	**v**	**2v**	9164.974	13226.73	12985.38	12549.02	12908.33
2	**w**	**2w**	-3323.52	-4631.64	-4558.41	-4422.3	-4547.68
2	**x**	**2x**	347.4674	459.0539	453.8212	443.9201	457.2537
2	**y**	**2y**	-7.80504	-10.1828	-10.0777	-9.87765	-10.1785
2	**z**	**2z**	0.048245	0.062621	0.062003	0.060822	0.062685
5	**a**	**5a**	4.429909	4.66383	5.088519	5.556609	5.782251
5	**b**	**5b**	0.471379	0.469208	0.465368	0.456843	0.450019
5	**v**	**5v**	12076.02	12708.39	12444.48	12014.62	11925.37
5	**w**	**5w**	-4376.4	-4608.66	-4521.69	-4387.57	-4379.8
5	**x**	**5x**	458.3946	483.2385	476.0001	466.1629	470.0423
5	**y**	**5y**	-10.3014	-10.8623	-10.7093	-10.5099	-10.6212
5	**z**	**5z**	0.063687	0.067162	0.06624	0.065061	0.06581
10	**a**	**10a**	5.077183	5.309414	5.840161	6.387433	6.791737
10	**b**	**10b**	0.467745	0.464092	0.461138	0.452901	0.449094
10	**v**	**10v**	14305.47	20383.02	20380.4	20659.73	19706.69
10	**w**	**10w**	-5191.99	-7169.29	-7163.93	-7265.44	-6956.05
10	**x**	**10x**	544.9559	716.6158	716.1845	727.7758	701.9847
10	**y**	**10y**	-12.2524	-15.929	-15.9201	-16.1857	-15.6401
10	**z**	**10z**	0.075764	0.098041	0.097989	0.099643	0.096355
100	**a**	**100a**	7.640131	7.831052	8.930251	10.03288	10.56608
100	**b**	**100b**	0.471151	0.464322	0.465097	0.459316	0.453522
100	**v**	**100v**	21119.82	30659.82	29881.99	28535.1	29052.56
100	**w**	**100w**	-7642.13	-10764.8	-10486.4	-10062.2	-10261.6
100	**x**	**100x**	798.6609	1073.105	1045.241	1012.097	1036.359
100	**y**	**100y**	-17.9389	-23.8375	-23.2181	-22.5312	-23.0939
100	**z**	**100z**	0.110882	0.146678	0.142866	0.138764	0.142287

Time series data for the various recurrence intervals are provided on the following pages.



2-Year	Precipitation Zone				
	1	2	3	4	5
	24-hour depth (inches)				
Time (hours)	2.64	2.81	3.17	3.7	4.05
0.000	0.0569349	0.0607305	0.0693649	0.0827388	0.0919325
0.083	0.0571277	0.0609356	0.069596	0.0830079	0.0922262
0.167	0.0573224	0.0611428	0.0698296	0.0832796	0.0925229
0.250	0.0575192	0.0613523	0.0700656	0.0835543	0.0928227
0.333	0.0577181	0.061564	0.0703041	0.0838318	0.0931256
0.417	0.0579192	0.0617779	0.0705451	0.0841122	0.0934316
0.500	0.0581224	0.0619941	0.0707887	0.0843956	0.0937409
0.583	0.0583278	0.0622127	0.0710349	0.084682	0.0940535
0.667	0.0585354	0.0624337	0.0712838	0.0849715	0.0943695
0.750	0.0587453	0.0626571	0.0715354	0.0852642	0.0946888
0.833	0.0589576	0.0628829	0.0717899	0.0855601	0.0950116
0.917	0.0591722	0.0631113	0.0720471	0.0858592	0.095338
1.000	0.0593893	0.0633423	0.0723072	0.0861617	0.095668
1.083	0.0596088	0.0635759	0.0725703	0.0864675	0.0960017
1.167	0.0598308	0.0638121	0.0728363	0.0867768	0.0963391
1.250	0.0600553	0.0640511	0.0731054	0.0870897	0.0966803
1.333	0.0602825	0.0642928	0.0733776	0.0874061	0.0970254
1.417	0.0605124	0.0645374	0.073653	0.0877261	0.0973744
1.500	0.0607449	0.0647848	0.0739316	0.0880499	0.0977275
1.583	0.0609802	0.0650352	0.0742135	0.0883775	0.0980848
1.667	0.0612183	0.0652886	0.0744987	0.0887089	0.0984462
1.750	0.0614594	0.065545	0.0747874	0.0890443	0.0988119
1.833	0.0617033	0.0658046	0.0750796	0.0893838	0.099182

2-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	2.64	2.81	3.17	3.7	4.05	
1.917	0.0619502	0.0660674	0.0753754	0.0897273	0.0995566	
2.000	0.0622002	0.0663334	0.0756748	0.0900751	0.0999357	
2.083	0.0624534	0.0666027	0.0759779	0.0904271	0.1003194	
2.167	0.0627097	0.0668754	0.0762848	0.0907836	0.1007079	
2.250	0.0629692	0.0671516	0.0765956	0.0911445	0.1011013	
2.333	0.0632321	0.0674313	0.0769104	0.0915099	0.1014995	
2.417	0.0634984	0.0677146	0.0772292	0.09188	0.1019029	
2.500	0.0637682	0.0680016	0.0775522	0.0922549	0.1023114	
2.583	0.0640415	0.0682924	0.0778793	0.0926347	0.1027252	
2.667	0.0643185	0.0685871	0.0782108	0.0930194	0.1031443	
2.750	0.0645991	0.0688857	0.0785467	0.0934092	0.103569	
2.833	0.0648835	0.0691883	0.0788872	0.0938042	0.1039993	
2.917	0.0651719	0.069495	0.0792322	0.0942046	0.1044354	
3.000	0.0654642	0.069806	0.079582	0.0946103	0.1048774	
3.083	0.0657605	0.0701213	0.0799366	0.0950217	0.1053254	
3.167	0.066061	0.070441	0.0802961	0.0954387	0.1057795	
3.250	0.0663658	0.0707652	0.0806608	0.0958615	0.10624	
3.333	0.0666749	0.0710941	0.0810306	0.0962904	0.1067069	
3.417	0.0669885	0.0714277	0.0814057	0.0967253	0.1071805	
3.500	0.0673066	0.0717661	0.0817862	0.0971665	0.1076608	
3.583	0.0676295	0.0721096	0.0821724	0.0976141	0.1081481	
3.667	0.0679571	0.0724581	0.0825642	0.0980683	0.1086425	
3.750	0.0682897	0.0728119	0.0829619	0.0985292	0.1091441	
3.833	0.0686273	0.073171	0.0833656	0.098997	0.1096533	
3.917	0.0689701	0.0735357	0.0837755	0.0994718	0.1101701	
4.000	0.0693181	0.073906	0.0841916	0.099954	0.1106947	
4.083	0.0696717	0.074282	0.0846143	0.1004436	0.1112274	
4.167	0.0700308	0.074664	0.0850436	0.1009408	0.1117684	
4.250	0.0703957	0.0750522	0.0854797	0.1014459	0.1123179	
4.333	0.0707665	0.0754466	0.0859229	0.1019591	0.1128761	
4.417	0.0711433	0.0758474	0.0863732	0.1024805	0.1134433	
4.500	0.0715264	0.0762549	0.086831	0.1030104	0.1140196	
4.583	0.0719158	0.0766691	0.0872964	0.1035491	0.1146054	
4.667	0.0723119	0.0770904	0.0877696	0.1040967	0.1152009	
4.750	0.0727147	0.0775188	0.0882508	0.1046536	0.1158065	
4.833	0.0731245	0.0779547	0.0887403	0.10522	0.1164223	
4.917	0.0735414	0.0783982	0.0892384	0.1057962	0.1170486	
5.000	0.0739658	0.0788495	0.0897452	0.1063825	0.1176859	

2-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	2.64	2.81	3.17	3.7	4.05	
5.083	0.0743977	0.0793089	0.0902611	0.1069791	0.1183344	
5.167	0.0748375	0.0797766	0.0907862	0.1075865	0.1189944	
5.250	0.0752853	0.080253	0.091321	0.1082048	0.1196663	
5.333	0.0757415	0.0807381	0.0918657	0.1088345	0.1203505	
5.417	0.0762063	0.0812324	0.0924205	0.1094759	0.1210473	
5.500	0.07668	0.0817362	0.0929859	0.1101293	0.1217572	
5.583	0.0771628	0.0822496	0.0935622	0.1107952	0.1224806	
5.667	0.077655	0.0827731	0.0941497	0.111474	0.1232178	
5.750	0.078157	0.083307	0.0947488	0.1121661	0.1239694	
5.833	0.0786692	0.0838516	0.0953599	0.1128719	0.1247358	
5.917	0.0791917	0.0844073	0.0959833	0.113592	0.1255176	
6.000	0.0797251	0.0849745	0.0966196	0.1143267	0.1263153	
6.083	0.0802696	0.0855536	0.0972692	0.1150766	0.1271293	
6.167	0.0808258	0.086145	0.0979325	0.1158423	0.1279603	
6.250	0.0813939	0.0867491	0.09861	0.1166242	0.128809	
6.333	0.0819744	0.0873664	0.0993023	0.1174231	0.1296759	
6.417	0.0825679	0.0879975	0.1000099	0.1182395	0.1305616	
6.500	0.0831747	0.0886427	0.1007334	0.119074	0.131467	
6.583	0.0837955	0.0893028	0.1014734	0.1199275	0.1323927	
6.667	0.0844307	0.0899781	0.1022305	0.1208005	0.1333396	
6.750	0.0850809	0.0906695	0.1030054	0.1216939	0.1343085	
6.833	0.0857467	0.0913774	0.1037988	0.1226084	0.1353002	
6.917	0.0864288	0.0921026	0.1046115	0.123545	0.1363156	
7.000	0.0871278	0.0928458	0.1054442	0.1245046	0.1373558	
7.083	0.0878444	0.0936077	0.1062979	0.1254881	0.1384217	
7.167	0.0885795	0.0943892	0.1071734	0.1264964	0.1395146	
7.250	0.0893337	0.0951911	0.1080716	0.1275308	0.1406354	
7.333	0.0901081	0.0960143	0.1089936	0.1285924	0.1417856	
7.417	0.0909034	0.0968598	0.1099405	0.1296824	0.1429663	
7.500	0.0917207	0.0977286	0.1109134	0.130802	0.1441789	
7.583	0.0925609	0.0986219	0.1119134	0.1319527	0.1454251	
7.667	0.0934252	0.0995407	0.112942	0.1331359	0.1467063	
7.750	0.0943148	0.1004863	0.1140005	0.1343533	0.1480242	
7.833	0.0952309	0.1014601	0.1150904	0.1356065	0.1493807	
7.917	0.0961749	0.1024635	0.1162133	0.1368973	0.1507777	
8.000	0.0971482	0.1034981	0.1173709	0.1382277	0.1522173	
8.083	0.0981524	0.1045654	0.118565	0.1395998	0.1537017	
8.167	0.0991891	0.1056674	0.1197976	0.1410158	0.1552334	

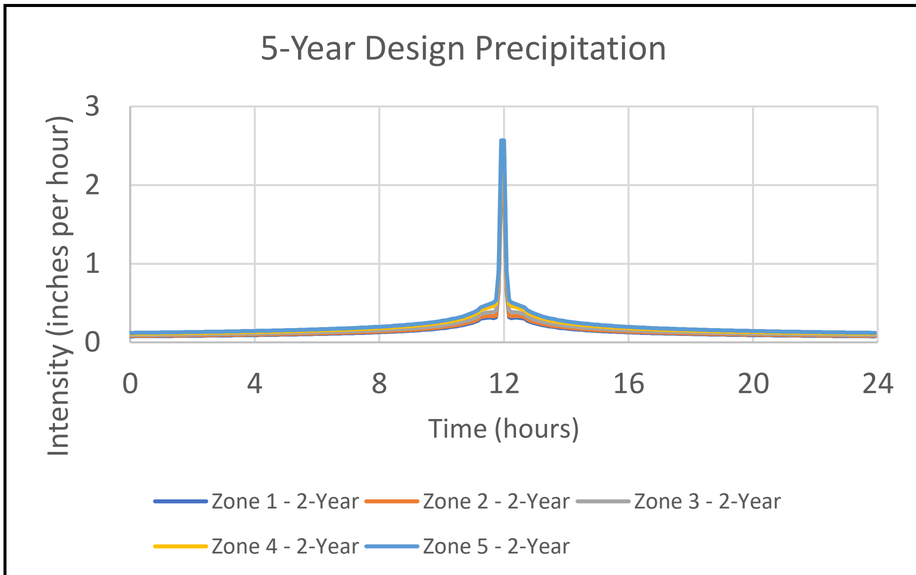
2-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	2.64	2.81	3.17	3.7	4.05	
8.250	0.1002602	0.1068058	0.1210709	0.142478	0.1568148	
8.333	0.1013676	0.1079828	0.1223871	0.1439892	0.1584489	
8.417	0.1025134	0.1092006	0.1237487	0.1455522	0.1601386	
8.500	0.1037	0.1104616	0.1251585	0.1471699	0.1618873	
8.583	0.1049297	0.1117685	0.1266193	0.1488458	0.1636984	
8.667	0.1062053	0.1131242	0.1281343	0.1505834	0.1655758	
8.750	0.1075298	0.1145317	0.129707	0.1523866	0.1675237	
8.833	0.1089063	0.1159944	0.1313412	0.1542597	0.1695467	
8.917	0.1103383	0.1175161	0.133041	0.1562075	0.1716499	
9.000	0.1118298	0.119101	0.134811	0.158235	0.1738387	
9.083	0.1133849	0.1207534	0.1366562	0.1603479	0.1761191	
9.167	0.1150083	0.1224784	0.138582	0.1625524	0.178498	
9.250	0.1167053	0.1242814	0.1405945	0.1648555	0.1809825	
9.333	0.1184816	0.1261687	0.1427006	0.1672647	0.1835809	
9.417	0.1203436	0.1281469	0.1449078	0.1697887	0.1863024	
9.500	0.1222984	0.1302237	0.1472244	0.1724368	0.1891569	
9.583	0.1243541	0.1324075	0.14966	0.1752198	0.192156	
9.667	0.1265196	0.134708	0.1522251	0.1781495	0.1953124	
9.750	0.1288053	0.1371359	0.1549316	0.1812396	0.1986406	
9.833	0.1312226	0.1397037	0.1577933	0.1845054	0.2021569	
9.917	0.1337848	0.1424252	0.1608256	0.1879643	0.2058799	
10.000	0.1365071	0.1453166	0.1640464	0.1916364	0.2098311	
10.083	0.1394069	0.1483964	0.167476	0.1955448	0.2140352	
10.167	0.1425045	0.1516862	0.1711384	0.1997163	0.2185205	
10.250	0.1458236	0.155211	0.1750612	0.204182	0.2233205	
10.333	0.1493921	0.1590004	0.1792773	0.2089788	0.2284743	
10.417	0.153243	0.1630894	0.1838252	0.2141502	0.2340282	
10.500	0.1574158	0.1675201	0.1887513	0.2197481	0.2400375	
10.583	0.1619584	0.1723431	0.1941116	0.2258353	0.2465691	
10.667	0.166929	0.1776202	0.1999743	0.2324885	0.2537045	
10.750	0.1724	0.183428	0.206424	0.2398022	0.2615441	
10.833	0.1784616	0.1898624	0.2135663	0.247895	0.270214	
10.917	0.1852293	0.1970457	0.221536	0.2569175	0.2798741	
11.000	0.1928526	0.2051363	0.2305077	0.267065	0.2907316	
11.083	0.2015295	0.2143444	0.2407128	0.278596	0.3030606	
11.167	0.2115295	0.2249555	0.2524654	0.2918608	0.3172324	
11.250	0.2335809	0.2506519	0.2793702	0.3202877	0.3471058	
11.333	0.2383891	0.2536929	0.284086	0.3272661	0.3549538	

2-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	2.64	2.81	3.17	3.7	4.05	
11.417	0.2426416	0.2554145	0.2878445	0.3337693	0.3624247	
11.500	0.2456112	0.2547296	0.2897061	0.3390485	0.3687838	
11.583	0.2461807	0.2501189	0.2883865	0.3421102	0.3730604	
11.667	0.2440806	0.2417544	0.2844206	0.3438767	0.3762718	
11.750	0.2551865	0.2546093	0.3030785	0.3694841	0.404302	
11.833	0.5248039	0.6389826	0.6910817	0.7562903	0.803162	
11.917	1.5501371	1.6118052	1.7373267	1.8931902	1.98842	
12.000	1.5501371	1.6118052	1.7373267	1.8931902	1.98842	
12.083	0.5248039	0.6389826	0.6910817	0.7562903	0.803162	
12.167	0.2551865	0.2546093	0.3030785	0.3694841	0.404302	
12.250	0.2440806	0.2417544	0.2844206	0.3438767	0.3762718	
12.333	0.2461807	0.2501189	0.2883865	0.3421102	0.3730604	
12.417	0.2456112	0.2547296	0.2897061	0.3390485	0.3687838	
12.500	0.2426416	0.2554145	0.2878445	0.3337693	0.3624247	
12.583	0.2383891	0.2536929	0.284086	0.3272661	0.3549538	
12.667	0.2335809	0.2506519	0.2793702	0.3202877	0.3471058	
12.750	0.2115295	0.2249555	0.2524654	0.2918608	0.3172324	
12.833	0.2015295	0.2143444	0.2407128	0.278596	0.3030606	
12.917	0.1928526	0.2051363	0.2305077	0.267065	0.2907316	
13.000	0.1852293	0.1970457	0.221536	0.2569175	0.2798741	
13.083	0.1784616	0.1898624	0.2135663	0.247895	0.270214	
13.167	0.1724	0.183428	0.206424	0.2398022	0.2615441	
13.250	0.166929	0.1776202	0.1999743	0.2324885	0.2537045	
13.333	0.1619584	0.1723431	0.1941116	0.2258353	0.2465691	
13.417	0.1574158	0.1675201	0.1887513	0.2197481	0.2400375	
13.500	0.153243	0.1630894	0.1838252	0.2141502	0.2340282	
13.583	0.1493921	0.1590004	0.1792773	0.2089788	0.2284743	
13.667	0.1458236	0.155211	0.1750612	0.204182	0.2233205	
13.750	0.1425045	0.1516862	0.1711384	0.1997163	0.2185205	
13.833	0.1394069	0.1483964	0.167476	0.1955448	0.2140352	
13.917	0.1365071	0.1453166	0.1640464	0.1916364	0.2098311	
14.000	0.1337848	0.1424252	0.1608256	0.1879643	0.2058799	
14.083	0.1312226	0.1397037	0.1577933	0.1845054	0.2021569	
14.167	0.1288053	0.1371359	0.1549316	0.1812396	0.1986406	
14.250	0.1265196	0.134708	0.1522251	0.1781495	0.1953124	
14.333	0.1243541	0.1324075	0.14966	0.1752198	0.192156	
14.417	0.1222984	0.1302237	0.1472244	0.1724368	0.1891569	
14.500	0.1203436	0.1281469	0.1449078	0.1697887	0.1863024	

2-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	2.64	2.81	3.17	3.7	4.05	
14.583	0.1184816	0.1261687	0.1427006	0.1672647	0.1835809	
14.667	0.1167053	0.1242814	0.1405945	0.1648555	0.1809825	
14.750	0.1150083	0.1224784	0.138582	0.1625524	0.178498	
14.833	0.1133849	0.1207534	0.1366562	0.1603479	0.1761191	
14.917	0.1118298	0.119101	0.134811	0.158235	0.1738387	
15.000	0.1103383	0.1175161	0.133041	0.1562075	0.1716499	
15.083	0.1089063	0.1159944	0.1313412	0.1542597	0.1695467	
15.167	0.1075298	0.1145317	0.129707	0.1523866	0.1675237	
15.250	0.1062053	0.1131242	0.1281343	0.1505834	0.1655758	
15.333	0.1049297	0.1117685	0.1266193	0.1488458	0.1636984	
15.417	0.1037	0.1104616	0.1251585	0.1471699	0.1618873	
15.500	0.1025134	0.1092006	0.1237487	0.1455522	0.1601386	
15.583	0.1013676	0.1079828	0.1223871	0.1439892	0.1584489	
15.667	0.1002602	0.1068058	0.1210709	0.142478	0.1568148	
15.750	0.0991891	0.1056674	0.1197976	0.1410158	0.1552334	
15.833	0.0981524	0.1045654	0.118565	0.1395998	0.1537017	
15.917	0.0971482	0.1034981	0.1173709	0.1382277	0.1522173	
16.000	0.0961749	0.1024635	0.1162133	0.1368973	0.1507777	
16.083	0.0952309	0.1014601	0.1150904	0.1356065	0.1493807	
16.167	0.0943148	0.1004863	0.1140005	0.1343533	0.1480242	
16.250	0.0934252	0.0995407	0.112942	0.1331359	0.1467063	
16.333	0.0925609	0.0986219	0.1119134	0.1319527	0.1454251	
16.417	0.0917207	0.0977286	0.1109134	0.130802	0.1441789	
16.500	0.0909034	0.0968598	0.1099405	0.1296824	0.1429663	
16.583	0.0901081	0.0960143	0.1089936	0.1285924	0.1417856	
16.667	0.0893337	0.0951911	0.1080716	0.1275308	0.1406354	
16.750	0.0885795	0.0943892	0.1071734	0.1264964	0.1395146	
16.833	0.0878444	0.0936077	0.1062979	0.1254881	0.1384217	
16.917	0.0871278	0.0928458	0.1054442	0.1245046	0.1373558	
17.000	0.0864288	0.0921026	0.1046115	0.123545	0.1363156	
17.083	0.0857467	0.0913774	0.1037988	0.1226084	0.1353002	
17.167	0.0850809	0.0906695	0.1030054	0.1216939	0.1343085	
17.250	0.0844307	0.0899781	0.1022305	0.1208005	0.1333396	
17.333	0.0837955	0.0893028	0.1014734	0.1199275	0.1323927	
17.417	0.0831747	0.0886427	0.1007334	0.119074	0.131467	
17.500	0.0825679	0.0879975	0.1000099	0.1182395	0.1305616	
17.583	0.0819744	0.0873664	0.0993023	0.1174231	0.1296759	
17.667	0.0813939	0.0867491	0.09861	0.1166242	0.128809	

2-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	2.64	2.81	3.17	3.7	4.05	
17.750	0.0808258	0.086145	0.0979325	0.1158423	0.1279603	
17.833	0.0802696	0.0855536	0.0972692	0.1150766	0.1271293	
17.917	0.0797251	0.0849745	0.0966196	0.1143267	0.1263153	
18.000	0.0791917	0.0844073	0.0959833	0.113592	0.1255176	
18.083	0.0786692	0.0838516	0.0953599	0.1128719	0.1247358	
18.167	0.078157	0.083307	0.0947488	0.1121661	0.1239694	
18.250	0.077655	0.0827731	0.0941497	0.111474	0.1232178	
18.333	0.0771628	0.0822496	0.0935622	0.1107952	0.1224806	
18.417	0.07668	0.0817362	0.0929859	0.1101293	0.1217572	
18.500	0.0762063	0.0812324	0.0924205	0.1094759	0.1210473	
18.583	0.0757415	0.0807381	0.0918657	0.1088345	0.1203505	
18.667	0.0752853	0.080253	0.091321	0.1082048	0.1196663	
18.750	0.0748375	0.0797766	0.0907862	0.1075865	0.1189944	
18.833	0.0743977	0.0793089	0.0902611	0.1069791	0.1183344	
18.917	0.0739658	0.0788495	0.0897452	0.1063825	0.1176859	
19.000	0.0735414	0.0783982	0.0892384	0.1057962	0.1170486	
19.083	0.0731245	0.0779547	0.0887403	0.10522	0.1164223	
19.167	0.0727147	0.0775188	0.0882508	0.1046536	0.1158065	
19.250	0.0723119	0.0770904	0.0877696	0.1040967	0.1152009	
19.333	0.0719158	0.0766691	0.0872964	0.1035491	0.1146054	
19.417	0.0715264	0.0762549	0.086831	0.1030104	0.1140196	
19.500	0.0711433	0.0758474	0.0863732	0.1024805	0.1134433	
19.583	0.0707665	0.0754466	0.0859229	0.1019591	0.1128761	
19.667	0.0703957	0.0750522	0.0854797	0.1014459	0.1123179	
19.750	0.0700308	0.074664	0.0850436	0.1009408	0.1117684	
19.833	0.0696717	0.074282	0.0846143	0.1004436	0.1112274	
19.917	0.0693181	0.073906	0.0841916	0.099954	0.1106947	
20.000	0.0689701	0.0735357	0.0837755	0.0994718	0.1101701	
20.083	0.0686273	0.073171	0.0833656	0.098997	0.1096533	
20.167	0.0682897	0.0728119	0.0829619	0.0985292	0.1091441	
20.250	0.0679571	0.0724581	0.0825642	0.0980683	0.1086425	
20.333	0.0676295	0.0721096	0.0821724	0.0976141	0.1081481	
20.417	0.0673066	0.0717661	0.0817862	0.0971665	0.1076608	
20.500	0.0669885	0.0714277	0.0814057	0.0967253	0.1071805	
20.583	0.0666749	0.0710941	0.0810306	0.0962904	0.1067069	
20.667	0.0663658	0.0707652	0.0806608	0.0958615	0.10624	
20.750	0.066061	0.070441	0.0802961	0.0954387	0.1057795	
20.833	0.0657605	0.0701213	0.0799366	0.0950217	0.1053254	

2-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	2.64	2.81	3.17	3.7	4.05	
20.917	0.0654642	0.069806	0.079582	0.0946103	0.1048774	
21.000	0.0651719	0.069495	0.0792322	0.0942046	0.1044354	
21.083	0.0648835	0.0691883	0.0788872	0.0938042	0.1039993	
21.167	0.0645991	0.0688857	0.0785467	0.0934092	0.103569	
21.250	0.0643185	0.0685871	0.0782108	0.0930194	0.1031443	
21.333	0.0640415	0.0682924	0.0778793	0.0926347	0.1027252	
21.417	0.0637682	0.0680016	0.0775522	0.0922549	0.1023114	
21.500	0.0634984	0.0677146	0.0772292	0.09188	0.1019029	
21.583	0.0632321	0.0674313	0.0769104	0.0915099	0.1014995	
21.667	0.0629692	0.0671516	0.0765956	0.0911445	0.1011013	
21.750	0.0627097	0.0668754	0.0762848	0.0907836	0.1007079	
21.833	0.0624534	0.0666027	0.0759779	0.0904271	0.1003194	
21.917	0.0622002	0.0663334	0.0756748	0.0900751	0.0999357	
22.000	0.0619502	0.0660674	0.0753754	0.0897273	0.0995566	
22.083	0.0617033	0.0658046	0.0750796	0.0893838	0.099182	
22.167	0.0614594	0.065545	0.0747874	0.0890443	0.0988119	
22.250	0.0612183	0.0652886	0.0744987	0.0887089	0.0984462	
22.333	0.0609802	0.0650352	0.0742135	0.0883775	0.0980848	
22.417	0.0607449	0.0647848	0.0739316	0.0880499	0.0977275	
22.500	0.0605124	0.0645374	0.073653	0.0877261	0.0973744	
22.583	0.0602825	0.0642928	0.0733776	0.0874061	0.0970254	
22.667	0.0600553	0.0640511	0.0731054	0.0870897	0.0966803	
22.750	0.0598308	0.0638121	0.0728363	0.0867768	0.0963391	
22.833	0.0596088	0.0635759	0.0725703	0.0864675	0.0960017	
22.917	0.0593893	0.0633423	0.0723072	0.0861617	0.095668	
23.000	0.0591722	0.0631113	0.0720471	0.0858592	0.095338	
23.083	0.0589576	0.0628829	0.0717899	0.0855601	0.0950116	
23.167	0.0587453	0.0626571	0.0715354	0.0852642	0.0946888	
23.250	0.0585354	0.0624337	0.0712838	0.0849715	0.0943695	
23.333	0.0583278	0.0622127	0.0710349	0.084682	0.0940535	
23.417	0.0581224	0.0619941	0.0707887	0.0843956	0.0937409	
23.500	0.0579192	0.0617779	0.0705451	0.0841122	0.0934316	
23.583	0.0577181	0.061564	0.0703041	0.0838318	0.0931256	
23.667	0.0575192	0.0613523	0.0700656	0.0835543	0.0928227	
23.750	0.0573224	0.0611428	0.0698296	0.0832796	0.0925229	
23.833	0.0571277	0.0609356	0.069596	0.0830079	0.0922262	
23.917	0.0569349	0.0607305	0.0693649	0.0827388	0.0919325	



5-Year	Precipitation Zone				
	1	2	3	4	5
	24-hour depth (inches)				
Time (hours)	3.45	3.69	4.14	4.81	5.26
0.000	0.076114	0.0817427	0.0923735	0.109031	0.1207265
0.083	0.0763653	0.0820114	0.0926746	0.1093798	0.1211071
0.167	0.0766193	0.0822828	0.0929788	0.1097323	0.1214915
0.250	0.0768758	0.0825571	0.0932862	0.1100884	0.1218799
0.333	0.0771351	0.0828343	0.0935968	0.1104483	0.1222723
0.417	0.0773971	0.0831144	0.0939107	0.1108119	0.1226688
0.500	0.077662	0.0833974	0.0942279	0.1111793	0.1230695
0.583	0.0779296	0.0836836	0.0945485	0.1115507	0.1234744
0.667	0.0782002	0.0839728	0.0948726	0.111926	0.1238836
0.750	0.0784738	0.0842651	0.0952002	0.1123054	0.1242973
0.833	0.0787503	0.0845607	0.0955314	0.112689	0.1247154
0.917	0.0790299	0.0848596	0.0958663	0.1130767	0.1251381
1.000	0.0793126	0.0851617	0.0962049	0.1134687	0.1255655
1.083	0.0795985	0.0854673	0.0965472	0.1138651	0.1259976
1.167	0.0798877	0.0857764	0.0968935	0.114266	0.1264345
1.250	0.0801801	0.0860889	0.0972436	0.1146714	0.1268764
1.333	0.080476	0.0864051	0.0975978	0.1150814	0.1273232
1.417	0.0807752	0.0867249	0.0979561	0.1154961	0.1277752
1.500	0.081078	0.0870485	0.0983186	0.1159156	0.1282324
1.583	0.0813843	0.0873758	0.0986853	0.1163401	0.1286949
1.667	0.0816943	0.0877071	0.0990564	0.1167695	0.1291628
1.750	0.082008	0.0880423	0.0994319	0.117204	0.1296362
1.833	0.0823254	0.0883816	0.0998119	0.1176437	0.1301153

5-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	3.45	3.69	4.14	4.81	5.26	
1.917	0.0826468	0.088725	0.1001965	0.1180887	0.1306001	
2.000	0.0829721	0.0890726	0.1005858	0.1185392	0.1310908	
2.083	0.0833014	0.0894245	0.10098	0.1189951	0.1315875	
2.167	0.0836348	0.0897808	0.101379	0.1194567	0.1320903	
2.250	0.0839725	0.0901415	0.1017831	0.1199241	0.1325994	
2.333	0.0843144	0.0905069	0.1021922	0.1203973	0.1331148	
2.417	0.0846607	0.0908769	0.1026066	0.1208765	0.1336367	
2.500	0.0850115	0.0912518	0.1030263	0.1213619	0.1341653	
2.583	0.0853669	0.0916314	0.1034515	0.1218536	0.1347007	
2.667	0.085727	0.0920161	0.1038822	0.1223516	0.135243	
2.750	0.0860918	0.0924059	0.1043187	0.1228562	0.1357924	
2.833	0.0864615	0.0928009	0.104761	0.1233675	0.1363491	
2.917	0.0868362	0.0932013	0.1052092	0.1238857	0.1369132	
3.000	0.0872161	0.0936071	0.1056635	0.1244109	0.1374849	
3.083	0.0876012	0.0940185	0.1061241	0.1249432	0.1380644	
3.167	0.0879916	0.0944356	0.106591	0.1254828	0.1386518	
3.250	0.0883875	0.0948585	0.1070645	0.12603	0.1392473	
3.333	0.088789	0.0952875	0.1075447	0.1265848	0.1398512	
3.417	0.0891963	0.0957225	0.1080317	0.1271475	0.1404636	
3.500	0.0896095	0.0961639	0.1085257	0.1277183	0.1410847	
3.583	0.0900287	0.0966117	0.1090269	0.1282973	0.1417147	
3.667	0.0904541	0.0970661	0.1095355	0.1288848	0.1423539	
3.750	0.0908858	0.0975272	0.1100516	0.1294809	0.1430025	
3.833	0.091324	0.0979953	0.1105755	0.130086	0.1436607	
3.917	0.0917689	0.0984705	0.1111073	0.1307001	0.1443287	
4.000	0.0922206	0.0989529	0.1116472	0.1313235	0.1450069	
4.083	0.0926794	0.0994429	0.1121954	0.1319566	0.1456954	
4.167	0.0931453	0.0999405	0.1127523	0.1325995	0.1463946	
4.250	0.0936186	0.100446	0.1133179	0.1332525	0.1471048	
4.333	0.0940996	0.1009596	0.1138926	0.1339158	0.1478261	
4.417	0.0945883	0.1014815	0.1144765	0.1345898	0.148559	
4.500	0.095085	0.102012	0.11507	0.1352748	0.1493037	
4.583	0.0955899	0.1025512	0.1156733	0.1359709	0.1500605	
4.667	0.0961034	0.1030995	0.1162866	0.1366787	0.1508299	
4.750	0.0966255	0.1036571	0.1169103	0.1373983	0.1516121	
4.833	0.0971566	0.1042242	0.1175447	0.1381301	0.1524076	
4.917	0.0976969	0.1048011	0.11819	0.1388745	0.1532167	
5.000	0.0982467	0.1053882	0.1188467	0.1396319	0.1540397	

5-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	3.45	3.69	4.14	4.81	5.26	
5.083	0.0988063	0.1059856	0.1195149	0.1404026	0.1548772	
5.167	0.0993759	0.1065938	0.1201951	0.141187	0.1557295	
5.250	0.0999559	0.1072131	0.1208877	0.1419856	0.1565972	
5.333	0.1005467	0.1078438	0.121593	0.1427988	0.1574806	
5.417	0.1011484	0.1084862	0.1223114	0.143627	0.1583802	
5.500	0.1017616	0.1091408	0.1230433	0.1444707	0.1592967	
5.583	0.1023865	0.109808	0.1237893	0.1453304	0.1602304	
5.667	0.1030235	0.110488	0.1245496	0.1462067	0.1611821	
5.750	0.1036731	0.1111814	0.1253249	0.1471	0.1621521	
5.833	0.1043356	0.1118886	0.1261155	0.148011	0.1631413	
5.917	0.1050115	0.1126102	0.1269221	0.1489402	0.1641501	
6.000	0.1057013	0.1133464	0.1277451	0.1498883	0.1651794	
6.083	0.1064054	0.114098	0.1285852	0.1508558	0.1662297	
6.167	0.1071244	0.1148654	0.129443	0.1518436	0.1673018	
6.250	0.1078588	0.1156492	0.130319	0.1528524	0.1683966	
6.333	0.1086091	0.11645	0.1312139	0.1538828	0.1695148	
6.417	0.1093759	0.1172684	0.1321285	0.1549357	0.1706572	
6.500	0.11016	0.1181051	0.1330635	0.1560119	0.1718249	
6.583	0.1109618	0.1189608	0.1340196	0.1571123	0.1730187	
6.667	0.1117821	0.1198362	0.1349978	0.1582379	0.1742396	
6.750	0.1126217	0.120732	0.1359987	0.1593896	0.1754888	
6.833	0.1134812	0.1216492	0.1370234	0.1605684	0.1767672	
6.917	0.1143616	0.1225886	0.1380728	0.1617755	0.1780762	
7.000	0.1152636	0.1235511	0.1391479	0.1630121	0.1794169	
7.083	0.1161883	0.1245376	0.1402499	0.1642793	0.1807907	
7.167	0.1171365	0.1255493	0.1413798	0.1655784	0.182199	
7.250	0.1181093	0.1265871	0.1425389	0.1669109	0.1836433	
7.333	0.1191077	0.1276522	0.1437284	0.1682782	0.1851251	
7.417	0.120133	0.128746	0.1449498	0.1696819	0.1866461	
7.500	0.1211863	0.1298696	0.1462044	0.1711236	0.1882082	
7.583	0.122269	0.1310245	0.1474939	0.1726051	0.1898132	
7.667	0.1233825	0.1322122	0.1488199	0.1741283	0.1914631	
7.750	0.1245283	0.1334343	0.1501842	0.1756952	0.1931602	
7.833	0.1257079	0.1346925	0.1515887	0.177308	0.1949067	
7.917	0.1269232	0.1359886	0.1530353	0.178969	0.1967051	
8.000	0.1281759	0.1373245	0.1545264	0.1806806	0.1985581	
8.083	0.129468	0.1387024	0.1560642	0.1824456	0.2004686	
8.167	0.1308016	0.1401246	0.1576512	0.1842667	0.2024396	

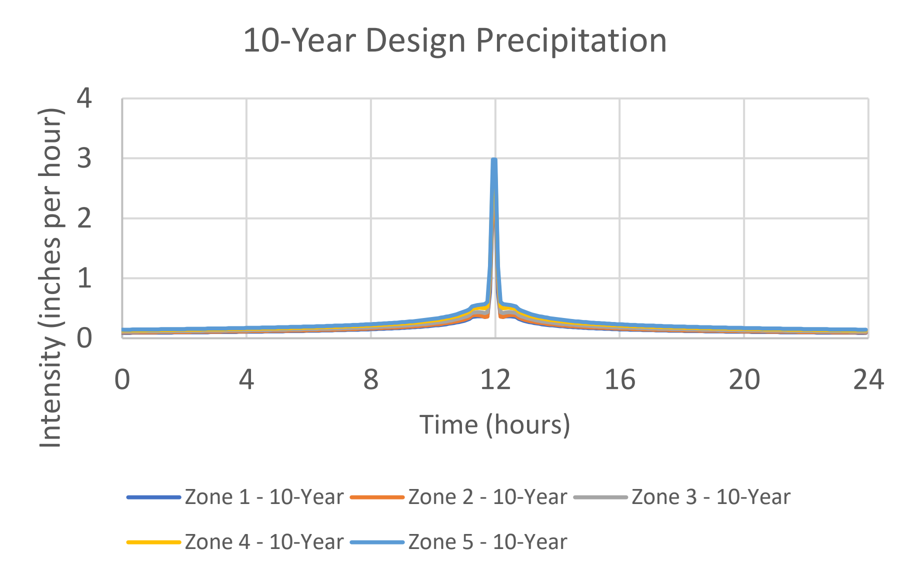
5-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	3.45	3.69	4.14	4.81	5.26	
8.250	0.1321791	0.1415935	0.1592902	0.1861471	0.2044744	
8.333	0.133603	0.1431116	0.160984	0.1880901	0.2065767	
8.417	0.1350758	0.144682	0.1627359	0.1900993	0.2087502	
8.500	0.1366005	0.1463075	0.1645493	0.1921786	0.2109992	
8.583	0.1381803	0.1479917	0.1664279	0.1943322	0.2133282	
8.667	0.1398185	0.1497381	0.1683757	0.1965647	0.2157421	
8.750	0.1415189	0.1515508	0.1703972	0.1988811	0.2182463	
8.833	0.1432856	0.1534339	0.1724971	0.2012868	0.2208466	
8.917	0.145123	0.1553923	0.1746807	0.2037879	0.2235495	
9.000	0.147036	0.1574312	0.1769538	0.2063909	0.226362	
9.083	0.1490301	0.1595563	0.1793227	0.209103	0.2292918	
9.167	0.151111	0.1617739	0.1817945	0.2119321	0.2323474	
9.250	0.1532854	0.1640909	0.1843768	0.214887	0.2355382	
9.333	0.1555606	0.1665152	0.1870783	0.2179774	0.2388746	
9.417	0.1579446	0.1690552	0.1899085	0.2212142	0.2423684	
9.500	0.1604465	0.1717207	0.1928781	0.2246094	0.2460323	
9.583	0.1630764	0.1745223	0.195999	0.2281766	0.2498809	
9.667	0.1658458	0.1774723	0.1992846	0.231931	0.2539305	
9.750	0.1687674	0.1805843	0.2027502	0.2358898	0.2581995	
9.833	0.171856	0.1838738	0.206413	0.2400725	0.2627088	
9.917	0.1751282	0.1873585	0.2102926	0.2445014	0.2674822	
10.000	0.1786032	0.1910588	0.2144115	0.2492017	0.2725468	
10.083	0.1823028	0.194998	0.2187957	0.254203	0.2779341	
10.167	0.1862527	0.1992034	0.2234752	0.2595392	0.2836803	
10.250	0.1904828	0.2037064	0.2284852	0.2652498	0.2898279	
10.333	0.1950279	0.2085445	0.2338668	0.2713816	0.2964267	
10.417	0.1999298	0.2137616	0.239669	0.2779897	0.3035355	
10.500	0.2052381	0.2194107	0.2459502	0.28514	0.3112247	
10.583	0.2110128	0.2255553	0.2527809	0.2929121	0.3195794	
10.667	0.2173271	0.2322732	0.2602472	0.3014029	0.3287029	
10.750	0.2242716	0.2396606	0.2684554	0.3107324	0.3387231	
10.833	0.2319596	0.2478376	0.2775387	0.3210503	0.3497997	
10.917	0.2405355	0.2569575	0.2876664	0.3325473	0.3621359	
11.000	0.2501862	0.2672187	0.2990581	0.3454703	0.3759944	
11.083	0.2611595	0.2788838	0.3120041	0.3601457	0.3917228	
11.167	0.2737915	0.2923096	0.3268983	0.3770158	0.4097916	
11.250	0.3022229	0.3224136	0.3585248	0.4107047	0.4450534	
11.333	0.3077256	0.3283505	0.3666522	0.4217369	0.4575469	

5-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	3.45	3.69	4.14	4.81	5.26	
11.417	0.3122695	0.3332966	0.3742773	0.4328883	0.4704011	
11.500	0.3147817	0.3361251	0.3804816	0.4434916	0.483014	
11.583	0.3135772	0.3350617	0.3838347	0.452514	0.494429	
11.667	0.307844	0.3292396	0.3840467	0.460265	0.504992	
11.750	0.3172672	0.3393177	0.4025268	0.4885342	0.5361612	
11.833	0.6595466	0.6995604	0.7703434	0.8608706	0.9090237	
11.917	1.9449833	2.0586955	2.2207669	2.4303244	2.5683801	
12.000	1.9449833	2.0586955	2.2207669	2.4303244	2.5683801	
12.083	0.6595466	0.6995604	0.7703434	0.8608706	0.9090237	
12.167	0.3172672	0.3393177	0.4025268	0.4885342	0.5361612	
12.250	0.307844	0.3292396	0.3840467	0.460265	0.504992	
12.333	0.3135772	0.3350617	0.3838347	0.452514	0.494429	
12.417	0.3147817	0.3361251	0.3804816	0.4434916	0.483014	
12.500	0.3122695	0.3332966	0.3742773	0.4328883	0.4704011	
12.583	0.3077256	0.3283505	0.3666522	0.4217369	0.4575469	
12.667	0.3022229	0.3224136	0.3585248	0.4107047	0.4450534	
12.750	0.2737915	0.2923096	0.3268983	0.3770158	0.4097916	
12.833	0.2611595	0.2788838	0.3120041	0.3601457	0.3917228	
12.917	0.2501862	0.2672187	0.2990581	0.3454703	0.3759944	
13.000	0.2405355	0.2569575	0.2876664	0.3325473	0.3621359	
13.083	0.2319596	0.2478376	0.2775387	0.3210503	0.3497997	
13.167	0.2242716	0.2396606	0.2684554	0.3107324	0.3387231	
13.250	0.2173271	0.2322732	0.2602472	0.3014029	0.3287029	
13.333	0.2110128	0.2255553	0.2527809	0.2929121	0.3195794	
13.417	0.2052381	0.2194107	0.2459502	0.28514	0.3112247	
13.500	0.1999298	0.2137616	0.239669	0.2779897	0.3035355	
13.583	0.1950279	0.2085445	0.2338668	0.2713816	0.2964267	
13.667	0.1904828	0.2037064	0.2284852	0.2652498	0.2898279	
13.750	0.1862527	0.1992034	0.2234752	0.2595392	0.2836803	
13.833	0.1823028	0.194998	0.2187957	0.254203	0.2779341	
13.917	0.1786032	0.1910588	0.2144115	0.2492017	0.2725468	
14.000	0.1751282	0.1873585	0.2102926	0.2445014	0.2674822	
14.083	0.171856	0.1838738	0.206413	0.2400725	0.2627088	
14.167	0.1687674	0.1805843	0.2027502	0.2358898	0.2581995	
14.250	0.1658458	0.1774723	0.1992846	0.231931	0.2539305	
14.333	0.1630764	0.1745223	0.195999	0.2281766	0.2498809	
14.417	0.1604465	0.1717207	0.1928781	0.2246094	0.2460323	
14.500	0.1579446	0.1690552	0.1899085	0.2212142	0.2423684	

5-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	3.45	3.69	4.14	4.81	5.26	
14.583	0.1555606	0.1665152	0.1870783	0.2179774	0.2388746	
14.667	0.1532854	0.1640909	0.1843768	0.214887	0.2355382	
14.750	0.151111	0.1617739	0.1817945	0.2119321	0.2323474	
14.833	0.1490301	0.1595563	0.1793227	0.209103	0.2292918	
14.917	0.147036	0.1574312	0.1769538	0.2063909	0.226362	
15.000	0.145123	0.1553923	0.1746807	0.2037879	0.2235495	
15.083	0.1432856	0.1534339	0.1724971	0.2012868	0.2208466	
15.167	0.1415189	0.1515508	0.1703972	0.1988811	0.2182463	
15.250	0.1398185	0.1497381	0.1683757	0.1965647	0.2157421	
15.333	0.1381803	0.1479917	0.1664279	0.1943322	0.2133282	
15.417	0.1366005	0.1463075	0.1645493	0.1921786	0.2109992	
15.500	0.1350758	0.144682	0.1627359	0.1900993	0.2087502	
15.583	0.133603	0.1431116	0.160984	0.1880901	0.2065767	
15.667	0.1321791	0.1415935	0.1592902	0.1861471	0.2044744	
15.750	0.1308016	0.1401246	0.1576512	0.1842667	0.2024396	
15.833	0.129468	0.1387024	0.1560642	0.1824456	0.2004686	
15.917	0.1281759	0.1373245	0.1545264	0.1806806	0.1985581	
16.000	0.1269232	0.1359886	0.1530353	0.178969	0.1967051	
16.083	0.1257079	0.1346925	0.1515887	0.177308	0.1949067	
16.167	0.1245283	0.1334343	0.1501842	0.1756952	0.1931602	
16.250	0.1233825	0.1322122	0.1488199	0.1741283	0.1914631	
16.333	0.122269	0.1310245	0.1474939	0.1726051	0.1898132	
16.417	0.1211863	0.1298696	0.1462044	0.1711236	0.1882082	
16.500	0.120133	0.128746	0.1449498	0.1696819	0.1866461	
16.583	0.1191077	0.1276522	0.1437284	0.1682782	0.1851251	
16.667	0.1181093	0.1265871	0.1425389	0.1669109	0.1836433	
16.750	0.1171365	0.1255493	0.1413798	0.1655784	0.182199	
16.833	0.1161883	0.1245376	0.1402499	0.1642793	0.1807907	
16.917	0.1152636	0.1235511	0.1391479	0.1630121	0.1794169	
17.000	0.1143616	0.1225886	0.1380728	0.1617755	0.1780762	
17.083	0.1134812	0.1216492	0.1370234	0.1605684	0.1767672	
17.167	0.1126217	0.120732	0.1359987	0.1593896	0.1754888	
17.250	0.1117821	0.1198362	0.1349978	0.1582379	0.1742396	
17.333	0.1109618	0.1189608	0.1340196	0.1571123	0.1730187	
17.417	0.11016	0.1181051	0.1330635	0.1560119	0.1718249	
17.500	0.1093759	0.1172684	0.1321285	0.1549357	0.1706572	
17.583	0.1086091	0.11645	0.1312139	0.1538828	0.1695148	
17.667	0.1078588	0.1156492	0.130319	0.1528524	0.1683966	

5-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	3.45	3.69	4.14	4.81	5.26	
17.750	0.1071244	0.1148654	0.129443	0.1518436	0.1673018	
17.833	0.1064054	0.114098	0.1285852	0.1508558	0.1662297	
17.917	0.1057013	0.1133464	0.1277451	0.1498883	0.1651794	
18.000	0.1050115	0.1126102	0.1269221	0.1489402	0.1641501	
18.083	0.1043356	0.1118886	0.1261155	0.148011	0.1631413	
18.167	0.1036731	0.1111814	0.1253249	0.1471	0.1621521	
18.250	0.1030235	0.110488	0.1245496	0.1462067	0.1611821	
18.333	0.1023865	0.109808	0.1237893	0.1453304	0.1602304	
18.417	0.1017616	0.1091408	0.1230433	0.1444707	0.1592967	
18.500	0.1011484	0.1084862	0.1223114	0.143627	0.1583802	
18.583	0.1005467	0.1078438	0.121593	0.1427988	0.1574806	
18.667	0.0999559	0.1072131	0.1208877	0.1419856	0.1565972	
18.750	0.0993759	0.1065938	0.1201951	0.141187	0.1557295	
18.833	0.0988063	0.1059856	0.1195149	0.1404026	0.1548772	
18.917	0.0982467	0.1053882	0.1188467	0.1396319	0.1540397	
19.000	0.0976969	0.1048011	0.11819	0.1388745	0.1532167	
19.083	0.0971566	0.1042242	0.1175447	0.1381301	0.1524076	
19.167	0.0966255	0.1036571	0.1169103	0.1373983	0.1516121	
19.250	0.0961034	0.1030995	0.1162866	0.1366787	0.1508299	
19.333	0.0955899	0.1025512	0.1156733	0.1359709	0.1500605	
19.417	0.095085	0.102012	0.11507	0.1352748	0.1493037	
19.500	0.0945883	0.1014815	0.1144765	0.1345898	0.148559	
19.583	0.0940996	0.1009596	0.1138926	0.1339158	0.1478261	
19.667	0.0936186	0.100446	0.1133179	0.1332525	0.1471048	
19.750	0.0931453	0.0999405	0.1127523	0.1325995	0.1463946	
19.833	0.0926794	0.0994429	0.1121954	0.1319566	0.1456954	
19.917	0.0922206	0.0989529	0.1116472	0.1313235	0.1450069	
20.000	0.0917689	0.0984705	0.1111073	0.1307001	0.1443287	
20.083	0.091324	0.0979953	0.1105755	0.130086	0.1436607	
20.167	0.0908858	0.0975272	0.1100516	0.1294809	0.1430025	
20.250	0.0904541	0.0970661	0.1095355	0.1288848	0.1423539	
20.333	0.0900287	0.0966117	0.1090269	0.1282973	0.1417147	
20.417	0.0896095	0.0961639	0.1085257	0.1277183	0.1410847	
20.500	0.0891963	0.0957225	0.1080317	0.1271475	0.1404636	
20.583	0.088789	0.0952875	0.1075447	0.1265848	0.1398512	
20.667	0.0883875	0.0948585	0.1070645	0.12603	0.1392473	
20.750	0.0879916	0.0944356	0.106591	0.1254828	0.1386518	
20.833	0.0876012	0.0940185	0.1061241	0.1249432	0.1380644	

5-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	3.45	3.69	4.14	4.81	5.26	
20.917	0.0872161	0.0936071	0.1056635	0.1244109	0.1374849	
21.000	0.0868362	0.0932013	0.1052092	0.1238857	0.1369132	
21.083	0.0864615	0.0928009	0.104761	0.1233675	0.1363491	
21.167	0.0860918	0.0924059	0.1043187	0.1228562	0.1357924	
21.250	0.085727	0.0920161	0.1038822	0.1223516	0.135243	
21.333	0.0853669	0.0916314	0.1034515	0.1218536	0.1347007	
21.417	0.0850115	0.0912518	0.1030263	0.1213619	0.1341653	
21.500	0.0846607	0.0908769	0.1026066	0.1208765	0.1336367	
21.583	0.0843144	0.0905069	0.1021922	0.1203973	0.1331148	
21.667	0.0839725	0.0901415	0.1017831	0.1199241	0.1325994	
21.750	0.0836348	0.0897808	0.101379	0.1194567	0.1320903	
21.833	0.0833014	0.0894245	0.10098	0.1189951	0.1315875	
21.917	0.0829721	0.0890726	0.1005858	0.1185392	0.1310908	
22.000	0.0826468	0.088725	0.1001965	0.1180887	0.1306001	
22.083	0.0823254	0.0883816	0.0998119	0.1176437	0.1301153	
22.167	0.082008	0.0880423	0.0994319	0.117204	0.1296362	
22.250	0.0816943	0.0877071	0.0990564	0.1167695	0.1291628	
22.333	0.0813843	0.0873758	0.0986853	0.1163401	0.1286949	
22.417	0.081078	0.0870485	0.0983186	0.1159156	0.1282324	
22.500	0.0807752	0.0867249	0.0979561	0.1154961	0.1277752	
22.583	0.080476	0.0864051	0.0975978	0.1150814	0.1273232	
22.667	0.0801801	0.0860889	0.0972436	0.1146714	0.1268764	
22.750	0.0798877	0.0857764	0.0968935	0.114266	0.1264345	
22.833	0.0795985	0.0854673	0.0965472	0.1138651	0.1259976	
22.917	0.0793126	0.0851617	0.0962049	0.1134687	0.1255655	
23.000	0.0790299	0.0848596	0.0958663	0.1130767	0.1251381	
23.083	0.0787503	0.0845607	0.0955314	0.112689	0.1247154	
23.167	0.0784738	0.0842651	0.0952002	0.1123054	0.1242973	
23.250	0.0782002	0.0839728	0.0948726	0.111926	0.1238836	
23.333	0.0779296	0.0836836	0.0945485	0.1115507	0.1234744	
23.417	0.077662	0.0833974	0.0942279	0.1111793	0.1230695	
23.500	0.0773971	0.0831144	0.0939107	0.1108119	0.1226688	
23.583	0.0771351	0.0828343	0.0935968	0.1104483	0.1222723	
23.667	0.0768758	0.0825571	0.0932862	0.1100884	0.1218799	
23.750	0.0766193	0.0822828	0.0929788	0.1097323	0.1214915	
23.833	0.0763653	0.0820114	0.0926746	0.1093798	0.1211071	
23.917	0.076114	0.0817427	0.0923735	0.109031	0.1207265	



10-Year	Precipitation Zone				
	1	2	3	4	5
	24-hour depth (inches)				
Time (hours)	4.06	4.36	4.9	5.69	6.22
0.000	0.0901866	0.097514	0.1101945	0.1299127	0.1429999
0.083	0.090482	0.097831	0.1105504	0.1303248	0.1434497
0.167	0.0907806	0.0981513	0.11091	0.1307412	0.1439041
0.250	0.0910822	0.0984748	0.1112733	0.1311618	0.1443631
0.333	0.091387	0.0988018	0.1116404	0.1315868	0.144827
0.417	0.0916951	0.0991323	0.1120114	0.1320163	0.1452957
0.500	0.0920064	0.0994662	0.1123864	0.1324502	0.1457693
0.583	0.0923211	0.0998037	0.1127653	0.1328888	0.1462479
0.667	0.0926392	0.1001449	0.1131483	0.1333321	0.1467316
0.750	0.0929607	0.1004898	0.1135355	0.1337802	0.1472206
0.833	0.0932858	0.1008384	0.1139269	0.1342331	0.1477148
0.917	0.0936144	0.1011909	0.1143226	0.134691	0.1482144
1.000	0.0939467	0.1015473	0.1147226	0.1351539	0.1487196
1.083	0.0942828	0.1019077	0.1151272	0.135622	0.1492303
1.167	0.0946226	0.1022721	0.1155363	0.1360953	0.1497467
1.250	0.0949663	0.1026407	0.1159501	0.136574	0.1502689
1.333	0.095314	0.1030136	0.1163685	0.1370581	0.1507971
1.417	0.0956657	0.1033907	0.1167918	0.1375477	0.1513313
1.500	0.0960215	0.1037722	0.1172201	0.138043	0.1518717
1.583	0.0963815	0.1041582	0.1176533	0.1385441	0.1524183
1.667	0.0967458	0.1045488	0.1180917	0.139051	0.1529713
1.750	0.0971144	0.104944	0.1185352	0.139564	0.1535309
1.833	0.0974874	0.105344	0.1189841	0.1400831	0.1540971

10-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	4.06	4.36	4.9	5.69	6.22	
1.917	0.097865	0.1057488	0.1194385	0.1406084	0.1546701	
2.000	0.0982472	0.1061586	0.1198983	0.1411401	0.15525	
2.083	0.0986342	0.1065734	0.1203639	0.1416783	0.155837	
2.167	0.0990259	0.1069934	0.1208352	0.1422231	0.1564313	
2.250	0.0994226	0.1074187	0.1213124	0.1427747	0.1570329	
2.333	0.0998243	0.1078493	0.1217956	0.1433333	0.157642	
2.417	0.1002312	0.1082854	0.122285	0.1438989	0.1582588	
2.500	0.1006433	0.1087271	0.1227806	0.1444717	0.1588835	
2.583	0.1010607	0.1091746	0.1232827	0.1450519	0.1595162	
2.667	0.1014837	0.1096279	0.1237914	0.1456397	0.1601572	
2.750	0.1019122	0.1100873	0.1243067	0.1462351	0.1608065	
2.833	0.1023465	0.1105527	0.1248289	0.1468385	0.1614643	
2.917	0.1027867	0.1110244	0.1253582	0.1474499	0.162131	
3.000	0.1032328	0.1115025	0.1258946	0.1480695	0.1628066	
3.083	0.1036851	0.1119872	0.1264383	0.1486976	0.1634913	
3.167	0.1041436	0.1124786	0.1269896	0.1493343	0.1641855	
3.250	0.1046086	0.1129769	0.1275485	0.1499798	0.1648893	
3.333	0.1050802	0.1134822	0.1281153	0.1506344	0.1656028	
3.417	0.1055584	0.1139946	0.1286902	0.1512982	0.1663265	
3.500	0.1060436	0.1145145	0.1292734	0.1519715	0.1670604	
3.583	0.1065359	0.1150419	0.1298649	0.1526545	0.1678049	
3.667	0.1070354	0.1155771	0.1304652	0.1533475	0.1685602	
3.750	0.1075423	0.1161202	0.1310743	0.1540506	0.1693266	
3.833	0.1080568	0.1166714	0.1316926	0.1547642	0.1701044	
3.917	0.1085792	0.1172309	0.1323201	0.1554885	0.1708938	
4.000	0.1091095	0.117799	0.1329573	0.1562238	0.1716951	
4.083	0.109648	0.1183759	0.1336042	0.1569704	0.1725087	
4.167	0.110195	0.1189618	0.1342613	0.1577286	0.1733349	
4.250	0.1107507	0.119557	0.1349287	0.1584986	0.1741739	
4.333	0.1113152	0.1201616	0.1356067	0.1592808	0.1750263	
4.417	0.1118888	0.120776	0.1362957	0.1600755	0.1758922	
4.500	0.1124719	0.1214004	0.1369958	0.1608831	0.1767721	
4.583	0.1130645	0.1220351	0.1377075	0.1617039	0.1776664	
4.667	0.1136671	0.1226804	0.138431	0.1625383	0.1785754	
4.750	0.1142799	0.1233366	0.1391667	0.1633866	0.1794996	
4.833	0.1149032	0.124004	0.139915	0.1642494	0.1804395	
4.917	0.1155372	0.124683	0.1406761	0.1651269	0.1813953	
5.000	0.1161824	0.1253737	0.1414505	0.1660196	0.1823678	

10-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	4.06	4.36	4.9	5.69	6.22	
5.083	0.116839	0.1260768	0.1422386	0.1669281	0.1833572	
5.167	0.1175074	0.1267923	0.1430408	0.1678526	0.1843642	
5.250	0.118188	0.1275209	0.1438575	0.1687938	0.1853893	
5.333	0.118881	0.1282629	0.1446891	0.1697521	0.1864329	
5.417	0.119587	0.1290186	0.1455362	0.1707281	0.1874958	
5.500	0.1203063	0.1297886	0.1463992	0.1717224	0.1885785	
5.583	0.1210394	0.1305732	0.1472786	0.1727354	0.1896816	
5.667	0.1217867	0.131373	0.148175	0.1737679	0.1908058	
5.750	0.1225486	0.1321885	0.1490889	0.1748204	0.1919518	
5.833	0.1233257	0.1330201	0.1500209	0.1758937	0.1931203	
5.917	0.1241185	0.1338685	0.1509716	0.1769884	0.1943121	
6.000	0.1249275	0.1347342	0.1519417	0.1781053	0.195528	
6.083	0.1257532	0.1356178	0.1529318	0.1792451	0.1967687	
6.167	0.1265964	0.13652	0.1539426	0.1804086	0.1980352	
6.250	0.1274575	0.1374414	0.1549749	0.1815967	0.1993284	
6.333	0.1283373	0.1383826	0.1560295	0.1828103	0.2006492	
6.417	0.1292364	0.1393446	0.1571071	0.1840503	0.2019987	
6.500	0.1301556	0.1403279	0.1582087	0.1853176	0.203378	
6.583	0.1310957	0.1413334	0.1593352	0.1866135	0.2047881	
6.667	0.1320573	0.1423621	0.1604874	0.1879388	0.2062302	
6.750	0.1330415	0.1434147	0.1616665	0.1892948	0.2077057	
6.833	0.134049	0.1444923	0.1628735	0.1906827	0.2092157	
6.917	0.1350809	0.1455959	0.1641095	0.1921038	0.2107618	
7.000	0.1361382	0.1467265	0.1653757	0.1935594	0.2123453	
7.083	0.1372218	0.1478853	0.1666734	0.1950511	0.2139679	
7.167	0.138333	0.1490734	0.1680039	0.1965802	0.2156312	
7.250	0.1394729	0.1502922	0.1693687	0.1981485	0.2173369	
7.333	0.1406428	0.151543	0.1707692	0.1997576	0.219087	
7.417	0.1418441	0.1528272	0.1722071	0.2014094	0.2208834	
7.500	0.1430782	0.1541464	0.1736841	0.2031059	0.2227281	
7.583	0.1443466	0.1555022	0.175202	0.204849	0.2246236	
7.667	0.1456509	0.1568963	0.1767627	0.2066411	0.2265721	
7.750	0.146993	0.1583307	0.1783684	0.2084845	0.2285762	
7.833	0.1483747	0.1598073	0.1800212	0.2103817	0.2306386	
7.917	0.1497979	0.1613282	0.1817235	0.2123354	0.2327624	
8.000	0.1512649	0.1628957	0.1834779	0.2143486	0.2349505	
8.083	0.152778	0.1645123	0.1852871	0.2164242	0.2372065	
8.167	0.1543396	0.1661806	0.1871541	0.2185658	0.2395339	

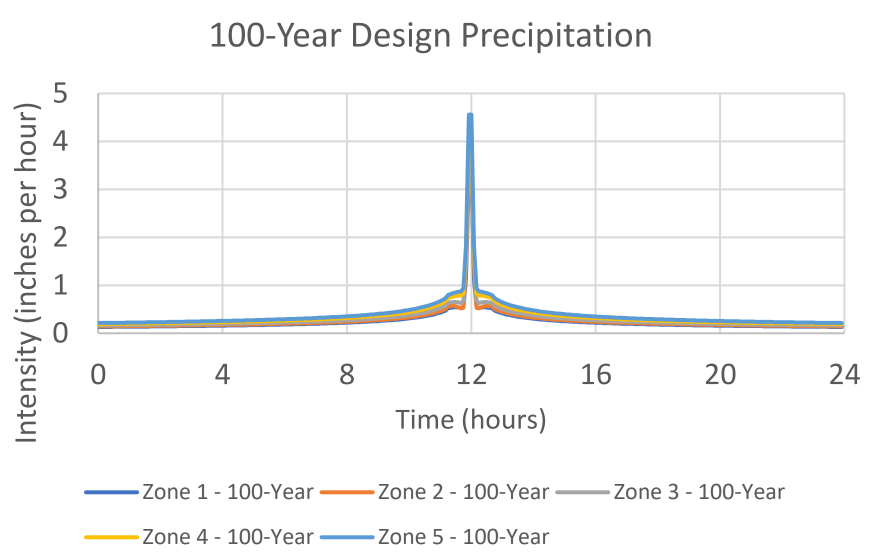
10-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	4.06	4.36	4.9	5.69	6.22	
8.250	0.1559524	0.1679035	0.189082	0.2207769	0.2419366	
8.333	0.1576192	0.169684	0.1910743	0.2230614	0.2444189	
8.417	0.1593433	0.1715255	0.1931346	0.2254235	0.2469853	
8.500	0.161128	0.1734316	0.1952671	0.2278677	0.2496407	
8.583	0.162977	0.1754061	0.197476	0.2303991	0.2523905	
8.667	0.1648942	0.1774533	0.199766	0.233023	0.2552405	
8.750	0.1668841	0.1795779	0.2021424	0.2357452	0.2581971	
8.833	0.1689512	0.1817848	0.2046108	0.2385721	0.2612671	
8.917	0.171101	0.1840797	0.2071772	0.2415107	0.264458	
9.000	0.1733389	0.1864685	0.2098485	0.2445688	0.2677783	
9.083	0.1756714	0.1889579	0.2126321	0.2477546	0.271237	
9.167	0.1781053	0.1915553	0.2155362	0.2510775	0.274844	
9.250	0.1806482	0.1942687	0.2185698	0.2545478	0.2786106	
9.333	0.1833087	0.1971073	0.2217429	0.2581768	0.2825491	
9.417	0.1860961	0.200081	0.2250668	0.2619771	0.286673	
9.500	0.1890211	0.2032009	0.2285539	0.2659631	0.2909977	
9.583	0.1920953	0.2064798	0.2322181	0.2701503	0.2955403	
9.667	0.1953321	0.2099315	0.2360753	0.2745567	0.30032	
9.750	0.1987464	0.2135722	0.240143	0.2792023	0.3053584	
9.833	0.2023554	0.2174198	0.2444415	0.2841099	0.3106803	
9.917	0.2061783	0.221495	0.2489937	0.2893054	0.3163135	
10.000	0.2102375	0.2258213	0.2538259	0.2948187	0.3222903	
10.083	0.2145585	0.230426	0.2589684	0.3006839	0.3286476	
10.167	0.2191711	0.2353406	0.2644562	0.3069407	0.3354283	
10.250	0.2241099	0.2406019	0.2703304	0.3136355	0.3426822	
10.333	0.2294158	0.2462532	0.276639	0.3208225	0.3504681	
10.417	0.2351369	0.2523457	0.2834392	0.3285662	0.3588554	
10.500	0.2413312	0.2589408	0.2907991	0.3369436	0.3679271	
10.583	0.2480684	0.2661123	0.298801	0.3460473	0.3777834	
10.667	0.2554335	0.2739505	0.3075452	0.3559907	0.3885461	
10.750	0.2635317	0.2825668	0.3171556	0.3669132	0.4003658	
10.833	0.2724947	0.2921009	0.3277875	0.3789898	0.4134308	
10.917	0.2824901	0.3027303	0.3396382	0.3924425	0.4279805	
11.000	0.293735	0.3146849	0.3529632	0.407559	0.4443246	
11.083	0.3065169	0.3282692	0.3681008	0.4247192	0.4628723	
11.167	0.3212257	0.343896	0.3855094	0.4444385	0.4841781	
11.250	0.3546764	0.3829784	0.4266561	0.4886233	0.5295381	
11.333	0.3607579	0.386248	0.4323934	0.4971986	0.5408805	

10-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	4.06	4.36	4.9	5.69	6.22	
11.417	0.3655798	0.3870288	0.4361683	0.5043297	0.5514413	
11.500	0.3678057	0.3833852	0.4362686	0.5084949	0.5599814	
11.583	0.3653154	0.3724718	0.4302339	0.5075565	0.5647928	
11.667	0.3568841	0.3534436	0.4179537	0.5020496	0.5669309	
11.750	0.365173	0.3618634	0.4366048	0.530998	0.604603	
11.833	0.7648547	0.9288165	1.0212994	1.1402746	1.2020408	
11.917	2.2679671	2.3640195	2.5616397	2.8106263	2.9816512	
12.000	2.2679671	2.3640195	2.5616397	2.8106263	2.9816512	
12.083	0.7648547	0.9288165	1.0212994	1.1402746	1.2020408	
12.167	0.365173	0.3618634	0.4366048	0.530998	0.604603	
12.250	0.3568841	0.3534436	0.4179537	0.5020496	0.5669309	
12.333	0.3653154	0.3724718	0.4302339	0.5075565	0.5647928	
12.417	0.3678057	0.3833852	0.4362686	0.5084949	0.5599814	
12.500	0.3655798	0.3870288	0.4361683	0.5043297	0.5514413	
12.583	0.3607579	0.386248	0.4323934	0.4971986	0.5408805	
12.667	0.3546764	0.3829784	0.4266561	0.4886233	0.5295381	
12.750	0.3212257	0.343896	0.3855094	0.4444385	0.4841781	
12.833	0.3065169	0.3282692	0.3681008	0.4247192	0.4628723	
12.917	0.293735	0.3146849	0.3529632	0.407559	0.4443246	
13.000	0.2824901	0.3027303	0.3396382	0.3924425	0.4279805	
13.083	0.2724947	0.2921009	0.3277875	0.3789898	0.4134308	
13.167	0.2635317	0.2825668	0.3171556	0.3669132	0.4003658	
13.250	0.2554335	0.2739505	0.3075452	0.3559907	0.3885461	
13.333	0.2480684	0.2661123	0.298801	0.3460473	0.3777834	
13.417	0.2413312	0.2589408	0.2907991	0.3369436	0.3679271	
13.500	0.2351369	0.2523457	0.2834392	0.3285662	0.3588554	
13.583	0.2294158	0.2462532	0.276639	0.3208225	0.3504681	
13.667	0.2241099	0.2406019	0.2703304	0.3136355	0.3426822	
13.750	0.2191711	0.2353406	0.2644562	0.3069407	0.3354283	
13.833	0.2145585	0.230426	0.2589684	0.3006839	0.3286476	
13.917	0.2102375	0.2258213	0.2538259	0.2948187	0.3222903	
14.000	0.2061783	0.221495	0.2489937	0.2893054	0.3163135	
14.083	0.2023554	0.2174198	0.2444415	0.2841099	0.3106803	
14.167	0.1987464	0.2135722	0.240143	0.2792023	0.3053584	
14.250	0.1953321	0.2099315	0.2360753	0.2745567	0.30032	
14.333	0.1920953	0.2064798	0.2322181	0.2701503	0.2955403	
14.417	0.1890211	0.2032009	0.2285539	0.2659631	0.2909977	
14.500	0.1860961	0.200081	0.2250668	0.2619771	0.286673	

10-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	4.06	4.36	4.9	5.69	6.22	
14.583	0.1833087	0.1971073	0.2217429	0.2581768	0.2825491	
14.667	0.1806482	0.1942687	0.2185698	0.2545478	0.2786106	
14.750	0.1781053	0.1915553	0.2155362	0.2510775	0.274844	
14.833	0.1756714	0.1889579	0.2126321	0.2477546	0.271237	
14.917	0.1733389	0.1864685	0.2098485	0.2445688	0.2677783	
15.000	0.171101	0.1840797	0.2071772	0.2415107	0.264458	
15.083	0.1689512	0.1817848	0.2046108	0.2385721	0.2612671	
15.167	0.1668841	0.1795779	0.2021424	0.2357452	0.2581971	
15.250	0.1648942	0.1774533	0.199766	0.233023	0.2552405	
15.333	0.162977	0.1754061	0.197476	0.2303991	0.2523905	
15.417	0.161128	0.1734316	0.1952671	0.2278677	0.2496407	
15.500	0.1593433	0.1715255	0.1931346	0.2254235	0.2469853	
15.583	0.1576192	0.169684	0.1910743	0.2230614	0.2444189	
15.667	0.1559524	0.1679035	0.189082	0.2207769	0.2419366	
15.750	0.1543396	0.1661806	0.1871541	0.2185658	0.2395339	
15.833	0.152778	0.1645123	0.1852871	0.2164242	0.2372065	
15.917	0.1512649	0.1628957	0.1834779	0.2143486	0.2349505	
16.000	0.1497979	0.1613282	0.1817235	0.2123354	0.2327624	
16.083	0.1483747	0.1598073	0.1800212	0.2103817	0.2306386	
16.167	0.146993	0.1583307	0.1783684	0.2084845	0.2285762	
16.250	0.1456509	0.1568963	0.1767627	0.2066411	0.2265721	
16.333	0.1443466	0.1555022	0.175202	0.204849	0.2246236	
16.417	0.1430782	0.1541464	0.1736841	0.2031059	0.2227281	
16.500	0.1418441	0.1528272	0.1722071	0.2014094	0.2208834	
16.583	0.1406428	0.151543	0.1707692	0.1997576	0.219087	
16.667	0.1394729	0.1502922	0.1693687	0.1981485	0.2173369	
16.750	0.138333	0.1490734	0.1680039	0.1965802	0.2156312	
16.833	0.1372218	0.1478853	0.1666734	0.1950511	0.2139679	
16.917	0.1361382	0.1467265	0.1653757	0.1935594	0.2123453	
17.000	0.1350809	0.1455959	0.1641095	0.1921038	0.2107618	
17.083	0.134049	0.1444923	0.1628735	0.1906827	0.2092157	
17.167	0.1330415	0.1434147	0.1616665	0.1892948	0.2077057	
17.250	0.1320573	0.1423621	0.1604874	0.1879388	0.2062302	
17.333	0.1310957	0.1413334	0.1593352	0.1866135	0.2047881	
17.417	0.1301556	0.1403279	0.1582087	0.1853176	0.203378	
17.500	0.1292364	0.1393446	0.1571071	0.1840503	0.2019987	
17.583	0.1283373	0.1383826	0.1560295	0.1828103	0.2006492	
17.667	0.1274575	0.1374414	0.1549749	0.1815967	0.1993284	

10-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	4.06	4.36	4.9	5.69	6.22	
17.750	0.1265964	0.13652	0.1539426	0.1804086	0.1980352	
17.833	0.1257532	0.1356178	0.1529318	0.1792451	0.1967687	
17.917	0.1249275	0.1347342	0.1519417	0.1781053	0.195528	
18.000	0.1241185	0.1338685	0.1509716	0.1769884	0.1943121	
18.083	0.1233257	0.1330201	0.1500209	0.1758937	0.1931203	
18.167	0.1225486	0.1321885	0.1490889	0.1748204	0.1919518	
18.250	0.1217867	0.131373	0.148175	0.1737679	0.1908058	
18.333	0.1210394	0.1305732	0.1472786	0.1727354	0.1896816	
18.417	0.1203063	0.1297886	0.1463992	0.1717224	0.1885785	
18.500	0.119587	0.1290186	0.1455362	0.1707281	0.1874958	
18.583	0.118881	0.1282629	0.1446891	0.1697521	0.1864329	
18.667	0.118188	0.1275209	0.1438575	0.1687938	0.1853893	
18.750	0.1175074	0.1267923	0.1430408	0.1678526	0.1843642	
18.833	0.116839	0.1260768	0.1422386	0.1669281	0.1833572	
18.917	0.1161824	0.1253737	0.1414505	0.1660196	0.1823678	
19.000	0.1155372	0.124683	0.1406761	0.1651269	0.1813953	
19.083	0.1149032	0.124004	0.139915	0.1642494	0.1804395	
19.167	0.1142799	0.1233366	0.1391667	0.1633866	0.1794996	
19.250	0.1136671	0.1226804	0.138431	0.1625383	0.1785754	
19.333	0.1130645	0.1220351	0.1377075	0.1617039	0.1776664	
19.417	0.1124719	0.1214004	0.1369958	0.1608831	0.1767721	
19.500	0.1118888	0.120776	0.1362957	0.1600755	0.1758922	
19.583	0.1113152	0.1201616	0.1356067	0.1592808	0.1750263	
19.667	0.1107507	0.119557	0.1349287	0.1584986	0.1741739	
19.750	0.110195	0.1189618	0.1342613	0.1577286	0.1733349	
19.833	0.109648	0.1183759	0.1336042	0.1569704	0.1725087	
19.917	0.1091095	0.117799	0.1329573	0.1562238	0.1716951	
20.000	0.1085792	0.1172309	0.1323201	0.1554885	0.1708938	
20.083	0.1080568	0.1166714	0.1316926	0.1547642	0.1701044	
20.167	0.1075423	0.1161202	0.1310743	0.1540506	0.1693266	
20.250	0.1070354	0.1155771	0.1304652	0.1533475	0.1685602	
20.333	0.1065359	0.1150419	0.1298649	0.1526545	0.1678049	
20.417	0.1060436	0.1145145	0.1292734	0.1519715	0.1670604	
20.500	0.1055584	0.1139946	0.1286902	0.1512982	0.1663265	
20.583	0.1050802	0.1134822	0.1281153	0.1506344	0.1656028	
20.667	0.1046086	0.1129769	0.1275485	0.1499798	0.1648893	
20.750	0.1041436	0.1124786	0.1269896	0.1493343	0.1641855	
20.833	0.1036851	0.1119872	0.1264383	0.1486976	0.1634913	

10-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	4.06	4.36	4.9	5.69	6.22	
20.917	0.1032328	0.1115025	0.1258946	0.1480695	0.1628066	
21.000	0.1027867	0.1110244	0.1253582	0.1474499	0.162131	
21.083	0.1023465	0.1105527	0.1248289	0.1468385	0.1614643	
21.167	0.1019122	0.1100873	0.1243067	0.1462351	0.1608065	
21.250	0.1014837	0.1096279	0.1237914	0.1456397	0.1601572	
21.333	0.1010607	0.1091746	0.1232827	0.1450519	0.1595162	
21.417	0.1006433	0.1087271	0.1227806	0.1444717	0.1588835	
21.500	0.1002312	0.1082854	0.122285	0.1438989	0.1582588	
21.583	0.0998243	0.1078493	0.1217956	0.1433333	0.157642	
21.667	0.0994226	0.1074187	0.1213124	0.1427747	0.1570329	
21.750	0.0990259	0.1069934	0.1208352	0.1422231	0.1564313	
21.833	0.0986342	0.1065734	0.1203639	0.1416783	0.155837	
21.917	0.0982472	0.1061586	0.1198983	0.1411401	0.15525	
22.000	0.097865	0.1057488	0.1194385	0.1406084	0.1546701	
22.083	0.0974874	0.105344	0.1189841	0.1400831	0.1540971	
22.167	0.0971144	0.104944	0.1185352	0.139564	0.1535309	
22.250	0.0967458	0.1045488	0.1180917	0.139051	0.1529713	
22.333	0.0963815	0.1041582	0.1176533	0.1385441	0.1524183	
22.417	0.0960215	0.1037722	0.1172201	0.138043	0.1518717	
22.500	0.0956657	0.1033907	0.1167918	0.1375477	0.1513313	
22.583	0.095314	0.1030136	0.1163685	0.1370581	0.1507971	
22.667	0.0949663	0.1026407	0.1159501	0.136574	0.1502689	
22.750	0.0946226	0.1022721	0.1155363	0.1360953	0.1497467	
22.833	0.0942828	0.1019077	0.1151272	0.135622	0.1492303	
22.917	0.0939467	0.1015473	0.1147226	0.1351539	0.1487196	
23.000	0.0936144	0.1011909	0.1143226	0.134691	0.1482144	
23.083	0.0932858	0.1008384	0.1139269	0.1342331	0.1477148	
23.167	0.0929607	0.1004898	0.1135355	0.1337802	0.1472206	
23.250	0.0926392	0.1001449	0.1131483	0.1333321	0.1467316	
23.333	0.0923211	0.0998037	0.1127653	0.1328888	0.1462479	
23.417	0.0920064	0.0994662	0.1123864	0.1324502	0.1457693	
23.500	0.0916951	0.0991323	0.1120114	0.1320163	0.1452957	
23.583	0.091387	0.0988018	0.1116404	0.1315868	0.144827	
23.667	0.0910822	0.0984748	0.1112733	0.1311618	0.1443631	
23.750	0.0907806	0.0981513	0.11091	0.1307412	0.1439041	
23.833	0.090482	0.097831	0.1105504	0.1303248	0.1434497	
23.917	0.0901866	0.097514	0.1101945	0.1299127	0.1429999	



100-Year	Precipitation Zone				
	1	2	3	4	5
	24-hour depth (inches)				
Time (hours)	5.96	6.42	7.28	8.53	9.37
0.000	0.1315464	0.1435257	0.162517	0.1924755	0.2136914
0.083	0.1319805	0.1439925	0.1630464	0.1930947	0.2143702
0.167	0.1324192	0.1444641	0.1635813	0.1937203	0.215056
0.250	0.1328624	0.1449407	0.1641218	0.1943524	0.2157488
0.333	0.1333103	0.1454222	0.1646679	0.1949911	0.2164488
0.417	0.1337629	0.1459088	0.1652198	0.1956365	0.2171562
0.500	0.1342204	0.1464005	0.1657776	0.1962888	0.2178711
0.583	0.1346828	0.1468976	0.1663414	0.196948	0.2185935
0.667	0.1351502	0.1474	0.1669112	0.1976143	0.2193237
0.750	0.1356227	0.1479078	0.1674873	0.1982878	0.2200617
0.833	0.1361004	0.1484212	0.1680696	0.1989686	0.2208078
0.917	0.1365834	0.1489403	0.1686584	0.1996569	0.221562
1.000	0.1370718	0.1494651	0.1692537	0.2003529	0.2223246
1.083	0.1375657	0.1499958	0.1698557	0.2010566	0.2230956
1.167	0.1380651	0.1505325	0.1704645	0.2017683	0.2238753
1.250	0.1385703	0.1510754	0.1710802	0.202488	0.2246637
1.333	0.1390813	0.1516244	0.1717029	0.2032159	0.2254612
1.417	0.1395983	0.1521798	0.1723329	0.2039522	0.2262677
1.500	0.1401213	0.1527416	0.1729702	0.204697	0.2270836
1.583	0.1406504	0.15331	0.173615	0.2054506	0.2279091
1.667	0.1411858	0.1538852	0.1742674	0.206213	0.2287442
1.750	0.1417277	0.1544672	0.1749276	0.2069846	0.2295891
1.833	0.1422761	0.1550562	0.1755958	0.2077653	0.2304442

100-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	5.96	6.42	7.28	8.53	9.37	
1.917	0.1428312	0.1556524	0.176272	0.2085555	0.2313096	
2.000	0.1433931	0.1562558	0.1769566	0.2093553	0.2321854	
2.083	0.143962	0.1568667	0.1776495	0.210165	0.233072	
2.167	0.1445379	0.1574852	0.1783511	0.2109846	0.2339696	
2.250	0.1451212	0.1581114	0.1790615	0.2118146	0.2348783	
2.333	0.1457118	0.1587456	0.1797809	0.2126549	0.2357984	
2.417	0.14631	0.1593879	0.1805095	0.213506	0.2367301	
2.500	0.1469159	0.1600384	0.1812475	0.214368	0.2376738	
2.583	0.1475298	0.1606973	0.181995	0.2152411	0.2386296	
2.667	0.1481517	0.1613649	0.1827524	0.2161257	0.2395979	
2.750	0.1487819	0.1620414	0.1835197	0.2170219	0.2405788	
2.833	0.1494206	0.1627268	0.1842973	0.21793	0.2415728	
2.917	0.1500678	0.1634215	0.1850854	0.2188503	0.24258	
3.000	0.150724	0.1641256	0.1858842	0.219783	0.2436008	
3.083	0.1513891	0.1648394	0.186694	0.2207285	0.2446356	
3.167	0.1520635	0.1655631	0.1875149	0.2216871	0.2456845	
3.250	0.1527474	0.1662968	0.1883474	0.222659	0.246748	
3.333	0.153441	0.167041	0.1891916	0.2236445	0.2478264	
3.417	0.1541445	0.1677957	0.1900478	0.2246441	0.24892	
3.500	0.1548581	0.1685613	0.1909164	0.225658	0.2500293	
3.583	0.1555822	0.169338	0.1917976	0.2266866	0.2511545	
3.667	0.156317	0.1701261	0.1926917	0.2277302	0.2522962	
3.750	0.1570627	0.1709259	0.1935991	0.2287892	0.2534546	
3.833	0.1578197	0.1717377	0.1945201	0.2298641	0.2546303	
3.917	0.1585881	0.1725618	0.1954551	0.2309551	0.2558236	
4.000	0.1593684	0.1733984	0.1964043	0.2320628	0.2570351	
4.083	0.1601607	0.174248	0.1973683	0.2331876	0.2582651	
4.167	0.1609655	0.1751109	0.1983473	0.2343298	0.2595142	
4.250	0.1617831	0.1759874	0.1993417	0.23549	0.2607828	
4.333	0.1626138	0.1768779	0.200352	0.2366687	0.2620716	
4.417	0.1634579	0.1777827	0.2013787	0.2378663	0.263381	
4.500	0.1643159	0.1787023	0.2024221	0.2390834	0.2647116	
4.583	0.1651881	0.1796371	0.2034827	0.2403205	0.266064	
4.667	0.1660749	0.1805874	0.204561	0.2415782	0.2674387	
4.750	0.1669767	0.1815538	0.2056575	0.242857	0.2688366	
4.833	0.167894	0.1825367	0.2067728	0.2441576	0.270258	
4.917	0.1688273	0.1835366	0.2079073	0.2454806	0.2717039	
5.000	0.1697769	0.184554	0.2090617	0.2468266	0.2731749	

100-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	5.96	6.42	7.28	8.53	9.37	
5.083	0.1707434	0.1855893	0.2102365	0.2481963	0.2746717	
5.167	0.1717273	0.1866432	0.2114324	0.2495905	0.2761951	
5.250	0.1727291	0.1877163	0.21265	0.2510099	0.2777459	
5.333	0.1737495	0.188809	0.2138899	0.2524553	0.2793249	
5.417	0.1747888	0.189922	0.2151529	0.2539274	0.2809331	
5.500	0.1758478	0.191056	0.2164397	0.2554271	0.2825714	
5.583	0.1769272	0.1922116	0.217751	0.2569554	0.2842407	
5.667	0.1780274	0.1933895	0.2190877	0.2585131	0.285942	
5.750	0.1791494	0.1945906	0.2204506	0.2601012	0.2876764	
5.833	0.1802937	0.1958154	0.2218406	0.2617207	0.2894449	
5.917	0.1814611	0.197065	0.2232585	0.2633727	0.2912488	
6.000	0.1826525	0.19834	0.2247054	0.2650583	0.2930892	
6.083	0.1838687	0.1996414	0.2261823	0.2667787	0.2949674	
6.167	0.1851105	0.2009701	0.2276902	0.268535	0.2968848	
6.250	0.1863788	0.2023271	0.2292302	0.2703287	0.2988427	
6.333	0.1876747	0.2037134	0.2308035	0.2721609	0.3008425	
6.417	0.1889992	0.2051302	0.2324113	0.2740332	0.3028859	
6.500	0.1903533	0.2065784	0.2340549	0.275947	0.3049745	
6.583	0.1917381	0.2080595	0.2357358	0.277904	0.3071099	
6.667	0.1931549	0.2095745	0.2374552	0.2799057	0.309294	
6.750	0.1946049	0.2111249	0.2392148	0.281954	0.3115287	
6.833	0.1960895	0.212712	0.2410161	0.2840507	0.313816	
6.917	0.19761	0.2143374	0.2428609	0.2861977	0.3161579	
7.000	0.1991679	0.2160027	0.2447509	0.2883971	0.3185569	
7.083	0.2007649	0.2177094	0.246688	0.2906512	0.3210151	
7.167	0.2024025	0.2194594	0.2486742	0.2929622	0.3235352	
7.250	0.2040826	0.2212545	0.2507117	0.2953327	0.3261199	
7.333	0.2058069	0.2230968	0.2528028	0.2977651	0.3287719	
7.417	0.2075777	0.2249883	0.2549498	0.3002624	0.3314943	
7.500	0.2093968	0.2269314	0.2571553	0.3028275	0.3342903	
7.583	0.2112667	0.2289283	0.259422	0.3054635	0.3371633	
7.667	0.2131898	0.2309818	0.2617529	0.3081738	0.340117	
7.750	0.2151686	0.2330945	0.2641511	0.310962	0.3431552	
7.833	0.2172059	0.2352694	0.2666199	0.313832	0.3462822	
7.917	0.2193046	0.2375096	0.2691628	0.3167879	0.3495024	
8.000	0.221468	0.2398185	0.2717838	0.3198341	0.3528206	
8.083	0.2236995	0.2421996	0.2744869	0.3229754	0.3562419	
8.167	0.2260027	0.244657	0.2772765	0.3262168	0.3597718	

100-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	5.96	6.42	7.28	8.53	9.37	
8.250	0.2283817	0.2471948	0.2801574	0.3295639	0.3634164	
8.333	0.2308406	0.2498174	0.2831348	0.3330226	0.367182	
8.417	0.2333841	0.2525299	0.2862142	0.3365993	0.3710756	
8.500	0.2360172	0.2553375	0.2894017	0.3403011	0.3751047	
8.583	0.2387454	0.258246	0.2927037	0.3441353	0.3792775	
8.667	0.2415745	0.2612616	0.2961274	0.3481103	0.3836028	
8.750	0.244511	0.2643911	0.2996805	0.3522349	0.3880902	
8.833	0.2475619	0.267642	0.3033715	0.3565189	0.3927504	
8.917	0.250735	0.2710224	0.3072096	0.3609729	0.3975949	
9.000	0.2540386	0.2745412	0.3112049	0.3656088	0.4026362	
9.083	0.257482	0.2782082	0.3153686	0.3704392	0.4078883	
9.167	0.2610755	0.2820343	0.3197131	0.3754784	0.4133665	
9.250	0.2648304	0.2860314	0.3242518	0.3807421	0.4190877	
9.333	0.2687593	0.2902129	0.329	0.3862477	0.4250707	
9.417	0.2728761	0.2945934	0.3339743	0.3920144	0.4313364	
9.500	0.2771964	0.2991894	0.3391935	0.398064	0.4379082	
9.583	0.2817378	0.3040195	0.3446786	0.4044205	0.444812	
9.667	0.28652	0.3091044	0.3504533	0.4111111	0.4520773	
9.750	0.2915651	0.3144676	0.3565441	0.4181666	0.4597372	
9.833	0.2968984	0.3201358	0.3629815	0.4256219	0.4678292	
9.917	0.3025487	0.3261391	0.3697998	0.4335166	0.4763963	
10.000	0.3085489	0.3325126	0.3770387	0.4418962	0.4854875	
10.083	0.3149372	0.3392962	0.3847436	0.4508132	0.4951593	
10.167	0.3217576	0.3465364	0.3929675	0.4603283	0.5054772	
10.250	0.3290615	0.3542875	0.401772	0.4705124	0.5165175	
10.333	0.3369095	0.3626133	0.4112295	0.4814488	0.52837	
10.417	0.3453733	0.3715891	0.421426	0.4932362	0.541141	
10.500	0.3545387	0.3813055	0.4324641	0.5059926	0.5549575	
10.583	0.3645093	0.3918712	0.4444677	0.5198601	0.5699725	
10.667	0.3754115	0.4034194	0.457588	0.5350125	0.5863729	
10.750	0.3874015	0.4161142	0.4720119	0.551664	0.6043891	
10.833	0.4006751	0.4301614	0.4879731	0.5700829	0.6243097	
10.917	0.4154813	0.4458226	0.5057692	0.5906105	0.6465012	
11.000	0.4321429	0.4634367	0.5257858	0.6136887	0.6714385	
11.083	0.4510876	0.4834524	0.5485331	0.6399019	0.6997489	
11.167	0.4728953	0.5064781	0.574703	0.6700425	0.732283	
11.250	0.522168	0.5645182	0.6356071	0.7347504	0.8005382	
11.333	0.5314969	0.568934	0.6451126	0.7504458	0.8188124	

100-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	5.96	6.42	7.28	8.53	9.37	
11.417	0.5391083	0.5695376	0.652043	0.7649645	0.8362899	
11.500	0.5431214	0.5634096	0.6540477	0.7765379	0.8512997	
11.583	0.5405925	0.5462747	0.6478214	0.7827724	0.8615945	
11.667	0.5301358	0.5169138	0.6338489	0.7854484	0.86926	
11.750	0.5463109	0.529021	0.6682873	0.8408032	0.9318794	
11.833	1.1444232	1.3808237	1.5403645	1.7122547	1.8271262	
11.917	3.3554163	3.4835572	3.8356302	4.2821834	4.5588402	
12.000	3.3554163	3.4835572	3.8356302	4.2821834	4.5588402	
12.083	1.1444232	1.3808237	1.5403645	1.7122547	1.8271262	
12.167	0.5463109	0.529021	0.6682873	0.8408032	0.9318794	
12.250	0.5301358	0.5169138	0.6338489	0.7854484	0.86926	
12.333	0.5405925	0.5462747	0.6478214	0.7827724	0.8615945	
12.417	0.5431214	0.5634096	0.6540477	0.7765379	0.8512997	
12.500	0.5391083	0.5695376	0.652043	0.7649645	0.8362899	
12.583	0.5314969	0.568934	0.6451126	0.7504458	0.8188124	
12.667	0.522168	0.5645182	0.6356071	0.7347504	0.8005382	
12.750	0.4728953	0.5064781	0.574703	0.6700425	0.732283	
12.833	0.4510876	0.4834524	0.5485331	0.6399019	0.6997489	
12.917	0.4321429	0.4634367	0.5257858	0.6136887	0.6714385	
13.000	0.4154813	0.4458226	0.5057692	0.5906105	0.6465012	
13.083	0.4006751	0.4301614	0.4879731	0.5700829	0.6243097	
13.167	0.3874015	0.4161142	0.4720119	0.551664	0.6043891	
13.250	0.3754115	0.4034194	0.457588	0.5350125	0.5863729	
13.333	0.3645093	0.3918712	0.4444677	0.5198601	0.5699725	
13.417	0.3545387	0.3813055	0.4324641	0.5059926	0.5549575	
13.500	0.3453733	0.3715891	0.421426	0.4932362	0.541141	
13.583	0.3369095	0.3626133	0.4112295	0.4814488	0.52837	
13.667	0.3290615	0.3542875	0.401772	0.4705124	0.5165175	
13.750	0.3217576	0.3465364	0.3929675	0.4603283	0.5054772	
13.833	0.3149372	0.3392962	0.3847436	0.4508132	0.4951593	
13.917	0.3085489	0.3325126	0.3770387	0.4418962	0.4854875	
14.000	0.3025487	0.3261391	0.3697998	0.4335166	0.4763963	
14.083	0.2968984	0.3201358	0.3629815	0.4256219	0.4678292	
14.167	0.2915651	0.3144676	0.3565441	0.4181666	0.4597372	
14.250	0.28652	0.3091044	0.3504533	0.4111111	0.4520773	
14.333	0.2817378	0.3040195	0.3446786	0.4044205	0.444812	
14.417	0.2771964	0.2991894	0.3391935	0.398064	0.4379082	
14.500	0.2728761	0.2945934	0.3339743	0.3920144	0.4313364	

100-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	5.96	6.42	7.28	8.53	9.37	
14.583	0.2687593	0.2902129	0.329	0.3862477	0.4250707	
14.667	0.2648304	0.2860314	0.3242518	0.3807421	0.4190877	
14.750	0.2610755	0.2820343	0.3197131	0.3754784	0.4133665	
14.833	0.257482	0.2782082	0.3153686	0.3704392	0.4078883	
14.917	0.2540386	0.2745412	0.3112049	0.3656088	0.4026362	
15.000	0.250735	0.2710224	0.3072096	0.3609729	0.3975949	
15.083	0.2475619	0.267642	0.3033715	0.3565189	0.3927504	
15.167	0.244511	0.2643911	0.2996805	0.3522349	0.3880902	
15.250	0.2415745	0.2612616	0.2961274	0.3481103	0.3836028	
15.333	0.2387454	0.258246	0.2927037	0.3441353	0.3792775	
15.417	0.2360172	0.2553375	0.2894017	0.3403011	0.3751047	
15.500	0.2333841	0.2525299	0.2862142	0.3365993	0.3710756	
15.583	0.2308406	0.2498174	0.2831348	0.3330226	0.367182	
15.667	0.2283817	0.2471948	0.2801574	0.3295639	0.3634164	
15.750	0.2260027	0.244657	0.2772765	0.3262168	0.3597718	
15.833	0.2236995	0.2421996	0.2744869	0.3229754	0.3562419	
15.917	0.221468	0.2398185	0.2717838	0.3198341	0.3528206	
16.000	0.2193046	0.2375096	0.2691628	0.3167879	0.3495024	
16.083	0.2172059	0.2352694	0.2666199	0.313832	0.3462822	
16.167	0.2151686	0.2330945	0.2641511	0.310962	0.3431552	
16.250	0.2131898	0.2309818	0.2617529	0.3081738	0.340117	
16.333	0.2112667	0.2289283	0.259422	0.3054635	0.3371633	
16.417	0.2093968	0.2269314	0.2571553	0.3028275	0.3342903	
16.500	0.2075777	0.2249883	0.2549498	0.3002624	0.3314943	
16.583	0.2058069	0.2230968	0.2528028	0.2977651	0.3287719	
16.667	0.2040826	0.2212545	0.2507117	0.2953327	0.3261199	
16.750	0.2024025	0.2194594	0.2486742	0.2929622	0.3235352	
16.833	0.2007649	0.2177094	0.246688	0.2906512	0.3210151	
16.917	0.1991679	0.2160027	0.2447509	0.2883971	0.3185569	
17.000	0.19761	0.2143374	0.2428609	0.2861977	0.3161579	
17.083	0.1960895	0.212712	0.2410161	0.2840507	0.313816	
17.167	0.1946049	0.2111249	0.2392148	0.281954	0.3115287	
17.250	0.1931549	0.2095745	0.2374552	0.2799057	0.309294	
17.333	0.1917381	0.2080595	0.2357358	0.277904	0.3071099	
17.417	0.1903533	0.2065784	0.2340549	0.275947	0.3049745	
17.500	0.1889992	0.2051302	0.2324113	0.2740332	0.3028859	
17.583	0.1876747	0.2037134	0.2308035	0.2721609	0.3008425	
17.667	0.1863788	0.2023271	0.2292302	0.2703287	0.2988427	

100-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	5.96	6.42	7.28	8.53	9.37	
17.750	0.1851105	0.2009701	0.2276902	0.268535	0.2968848	
17.833	0.1838687	0.1996414	0.2261823	0.2667787	0.2949674	
17.917	0.1826525	0.19834	0.2247054	0.2650583	0.2930892	
18.000	0.1814611	0.197065	0.2232585	0.2633727	0.2912488	
18.083	0.1802937	0.1958154	0.2218406	0.2617207	0.2894449	
18.167	0.1791494	0.1945906	0.2204506	0.2601012	0.2876764	
18.250	0.1780274	0.1933895	0.2190877	0.2585131	0.285942	
18.333	0.1769272	0.1922116	0.217751	0.2569554	0.2842407	
18.417	0.1758478	0.191056	0.2164397	0.2554271	0.2825714	
18.500	0.1747888	0.189922	0.2151529	0.2539274	0.2809331	
18.583	0.1737495	0.188809	0.2138899	0.2524553	0.2793249	
18.667	0.1727291	0.1877163	0.21265	0.2510099	0.2777459	
18.750	0.1717273	0.1866432	0.2114324	0.2495905	0.2761951	
18.833	0.1707434	0.1855893	0.2102365	0.2481963	0.2746717	
18.917	0.1697769	0.184554	0.2090617	0.2468266	0.2731749	
19.000	0.1688273	0.1835366	0.2079073	0.2454806	0.2717039	
19.083	0.167894	0.1825367	0.2067728	0.2441576	0.270258	
19.167	0.1669767	0.1815538	0.2056575	0.242857	0.2688366	
19.250	0.1660749	0.1805874	0.204561	0.2415782	0.2674387	
19.333	0.1651881	0.1796371	0.2034827	0.2403205	0.266064	
19.417	0.1643159	0.1787023	0.2024221	0.2390834	0.2647116	
19.500	0.1634579	0.1777827	0.2013787	0.2378663	0.263381	
19.583	0.1626138	0.1768779	0.200352	0.2366687	0.2620716	
19.667	0.1617831	0.1759874	0.1993417	0.23549	0.2607828	
19.750	0.1609655	0.1751109	0.1983473	0.2343298	0.2595142	
19.833	0.1601607	0.174248	0.1973683	0.2331876	0.2582651	
19.917	0.1593684	0.1733984	0.1964043	0.2320628	0.2570351	
20.000	0.1585881	0.1725618	0.1954551	0.2309551	0.2558236	
20.083	0.1578197	0.1717377	0.1945201	0.2298641	0.2546303	
20.167	0.1570627	0.1709259	0.1935991	0.2287892	0.2534546	
20.250	0.156317	0.1701261	0.1926917	0.2277302	0.2522962	
20.333	0.1555822	0.169338	0.1917976	0.2266866	0.2511545	
20.417	0.1548581	0.1685613	0.1909164	0.225658	0.2500293	
20.500	0.1541445	0.1677957	0.1900478	0.2246441	0.24892	
20.583	0.153441	0.167041	0.1891916	0.2236445	0.2478264	
20.667	0.1527474	0.1662968	0.1883474	0.222659	0.246748	
20.750	0.1520635	0.1655631	0.1875149	0.2216871	0.2456845	
20.833	0.1513891	0.1648394	0.186694	0.2207285	0.2446356	

100-Year	Precipitation Zone					
	1	2	3	4	5	
	24-hour depth (inches)					
Time (hours)	5.96	6.42	7.28	8.53	9.37	
20.917	0.150724	0.1641256	0.1858842	0.219783	0.2436008	
21.000	0.1500678	0.1634215	0.1850854	0.2188503	0.24258	
21.083	0.1494206	0.1627268	0.1842973	0.21793	0.2415728	
21.167	0.1487819	0.1620414	0.1835197	0.2170219	0.2405788	
21.250	0.1481517	0.1613649	0.1827524	0.2161257	0.2395979	
21.333	0.1475298	0.1606973	0.181995	0.2152411	0.2386296	
21.417	0.1469159	0.1600384	0.1812475	0.214368	0.2376738	
21.500	0.14631	0.1593879	0.1805095	0.213506	0.2367301	
21.583	0.1457118	0.1587456	0.1797809	0.2126549	0.2357984	
21.667	0.1451212	0.1581114	0.1790615	0.2118146	0.2348783	
21.750	0.1445379	0.1574852	0.1783511	0.2109846	0.2339696	
21.833	0.143962	0.1568667	0.1776495	0.210165	0.233072	
21.917	0.1433931	0.1562558	0.1769566	0.2093553	0.2321854	
22.000	0.1428312	0.1556524	0.176272	0.2085555	0.2313096	
22.083	0.1422761	0.1550562	0.1755958	0.2077653	0.2304442	
22.167	0.1417277	0.1544672	0.1749276	0.2069846	0.2295891	
22.250	0.1411858	0.1538852	0.1742674	0.206213	0.2287442	
22.333	0.1406504	0.15331	0.173615	0.2054506	0.2279091	
22.417	0.1401213	0.1527416	0.1729702	0.204697	0.2270836	
22.500	0.1395983	0.1521798	0.1723329	0.2039522	0.2262677	
22.583	0.1390813	0.1516244	0.1717029	0.2032159	0.2254612	
22.667	0.1385703	0.1510754	0.1710802	0.202488	0.2246637	
22.750	0.1380651	0.1505325	0.1704645	0.2017683	0.2238753	
22.833	0.1375657	0.1499958	0.1698557	0.2010566	0.2230956	
22.917	0.1370718	0.1494651	0.1692537	0.2003529	0.2223246	
23.000	0.1365834	0.1489403	0.1686584	0.1996569	0.221562	
23.083	0.1361004	0.1484212	0.1680696	0.1989686	0.2208078	
23.167	0.1356227	0.1479078	0.1674873	0.1982878	0.2200617	
23.250	0.1351502	0.1474	0.1669112	0.1976143	0.2193237	
23.333	0.1346828	0.1468976	0.1663414	0.196948	0.2185935	
23.417	0.1342204	0.1464005	0.1657776	0.1962888	0.2178711	
23.500	0.1337629	0.1459088	0.1652198	0.1956365	0.2171562	
23.583	0.1333103	0.1454222	0.1646679	0.1949911	0.2164488	
23.667	0.1328624	0.1449407	0.1641218	0.1943524	0.2157488	
23.750	0.1324192	0.1444641	0.1635813	0.1937203	0.215056	
23.833	0.1319805	0.1439925	0.1630464	0.1930947	0.2143702	
23.917	0.1315464	0.1435257	0.162517	0.1924755	0.2136914	

City of Chico

Storm Water Master Plan

Appendix D – Potential Flood Conditions at Barber Yard

WOOD RODGERS

TECHNICAL MEMORANDUM

TO: Mr. Richard Burgi, PE, City of Chico

FROM: Mr. Harvey Oslick, PE, CFM, CPSWQ, EnvSP, Wood Rodgers, Inc.

DATE: June 7, 2022

SUBJECT: Potential Flood Conditions at Barber Yard, APN 039-400-031-000

REGISTERED PROFESSIONAL ENGINEER HARVEY R. OSLICK No. 54466 Exp. 12/31/23 CIVIL STATE OF CALIFORNIA

PURPOSE

The purpose of this Technical Memorandum (TM) is to present information regarding the potential for flooding at Barber Yard, a parcel located near the southwestern city limit within the city of Chico (City) between Little Chico Creek to the north and Comanche Creek to the south.

BACKGROUND

Wood Rodgers, Inc. (Wood Rodgers) is in the process of preparing a Storm Water Master Plan (SWMP) for the City. As part of the SWMP, Wood Rodgers has prepared a preliminary hydraulic model that simulates flooding along the streams around and through the City. The model was developed in the computer program HEC-RAS. Flows that are not contained within the modeled streams are routed across a two-dimensional mesh that simulates how flows would be expected to drain along roads and other overland flow areas. This model does not include underground storm drains. Though capable of simulating levee breaches, running simulations of levee breach scenarios is not in Wood Rodgers' scope of work.

The City provided Wood Rodgers with information about concepts being proposed to discharge runoff from Barber Yard (Site) into Comanche Creek so that Wood Rodgers would be aware of this during the development of the SWMP.

Wood Rodgers did not note any issues with the proposed drainage improvements. However, Wood Rodgers did notice a potential for site flooding and brought this to the City's attention.

SITE TOPOGRAPHY

Topographic data for most of the Site is available from 2018 USGS LiDAR data. Wood Rodgers is also using 2007 CA DWR LiDAR for the SWMP that covers the area of the Site not covered by the 2018 LiDAR.

The Site slopes downwards from east to west from an elevation of approximately 199 feet (all elevations are in NAVD88) to less than 190 feet. The railroad tracks to the west of the Site are at an elevation of approximately 193.8 feet. There is no defined overland release path from the Site. Estes Road to the south has a minimum elevation of approximately 192 feet. The overland release path towards Little Chico Creek has a minimum elevation of approximately 192 feet and the overland release path towards Comanche Creek has a minimum elevation of approximately 192.5 feet. There is one culvert under the railroad tracks near Estes Road and another culvert under the railroad tracks approximately 135 feet north of Comanche Creek. These culverts were not modeled.

The Site topography makes it so that flows originating offsite can flow onto the Site from the east and become trapped in the low ground until releasing to the north.

SITE FLOOD POTENTIAL

Wood Rodgers modeled 100-year flows in the HEC-RAS streams model prepared for the SWMP. The HEC-RAS model does not simulate flooding from rainfall within the City and does not include street storm drainage systems. It models overland flows resulting from stream flows that are not confined within the stream channels. The flows reaching the Site originate from overtopping of the Little Chico Creek Diversion Channel. Exhibit 1 shows the HEC-RAS model peak flood depth results. These results show a maximum flooding depth of approximately two feet within Barber Yard.

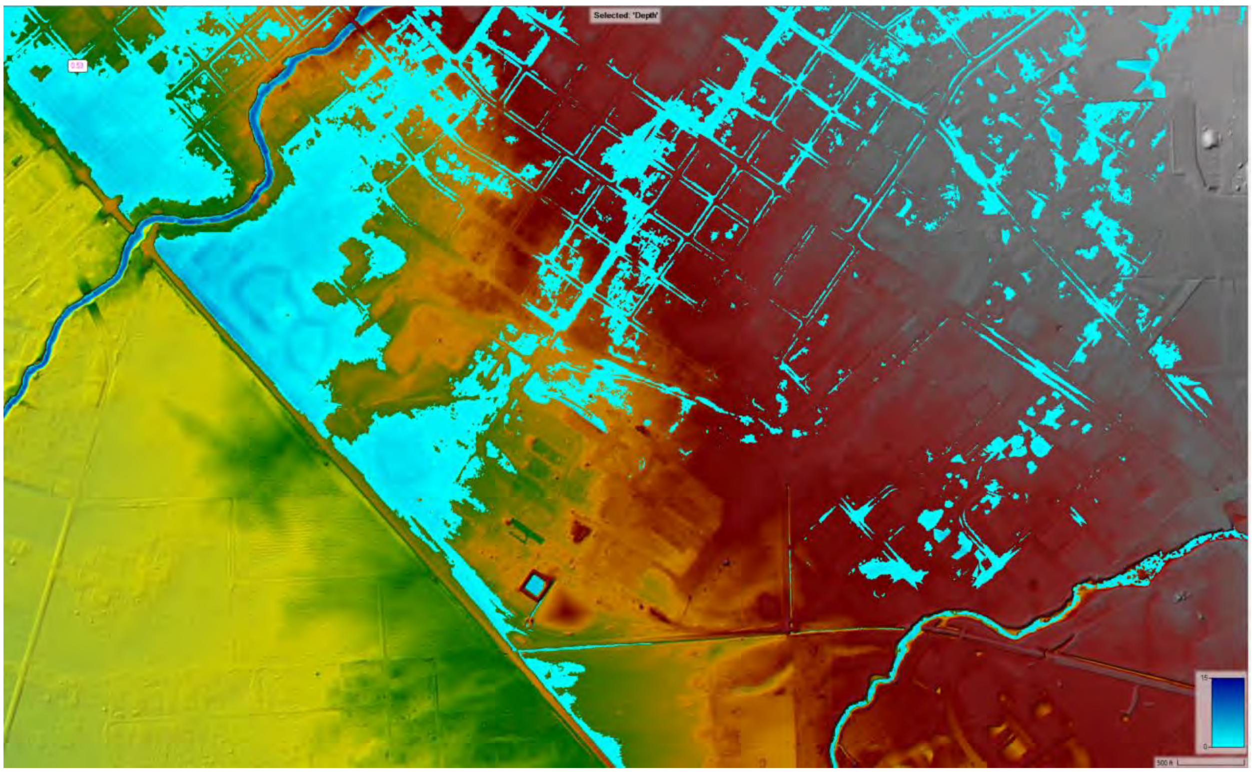


Exhibit 1: 100-Year Flooding at Barber Yard

Exhibit 2 shows the 200-year flood map for the City that was included in the 2019 Butte County Flood Hazard Mitigation Plan. The mapping includes flooding based on levee failures within the Butte Creek system.

Both Exhibit 1 and Exhibit 2 show similar flood conditions at Barber Yard. Therefore, there are multiple potential sources of flooding that could reach Barber Yard. The maximum flood depth that could reasonable be expected to occur at the Site would be controlled by the overland release path towards Little Chico Creek. It is unlikely that the Site could flood to an elevation over 193 feet based on the topographic constraints.

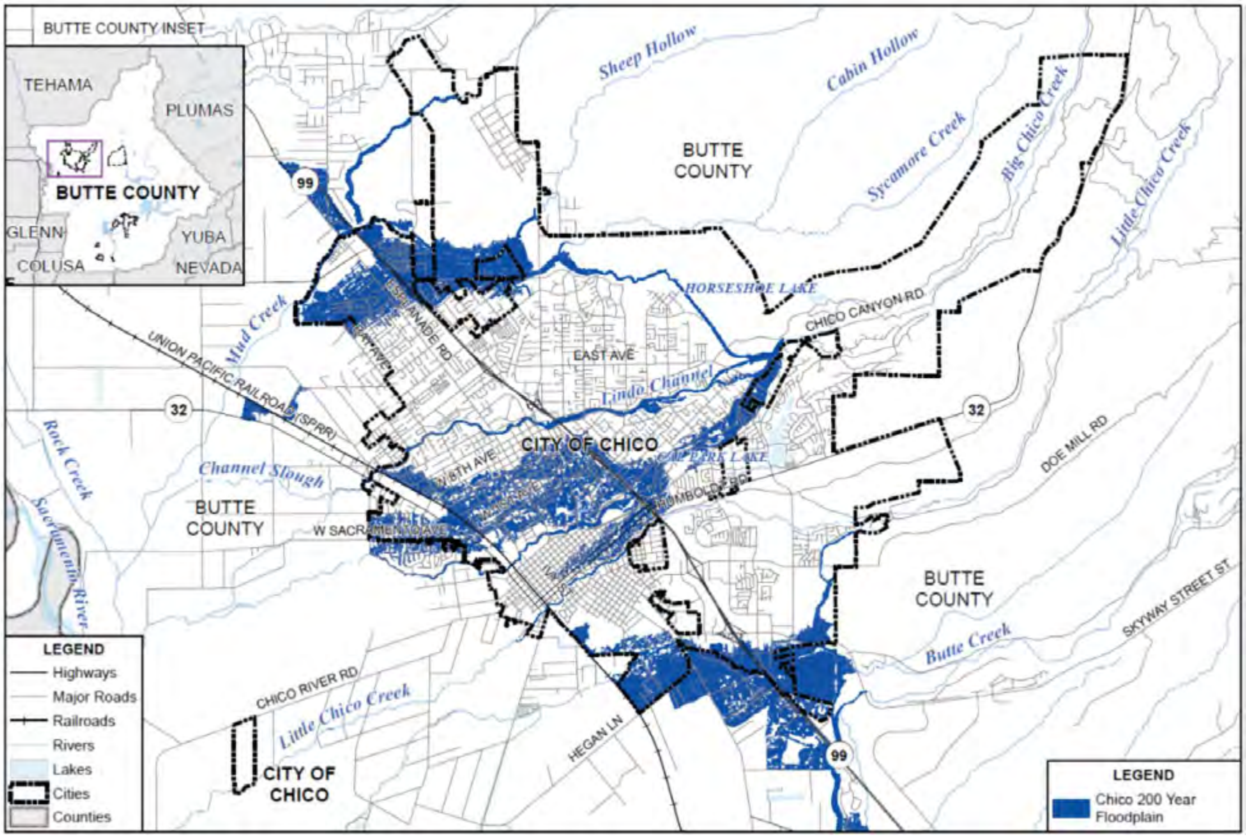


Exhibit 2: Figure B-18 from the Butte County Local Hazard Mitigation Plan (2019)

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS

City of Chico

Storm Water Master Plan

Appendix E – Levee Accreditation Process

WOOD RODGERS

TECHNICAL MEMORANDUM – DRAFT

TO:	Mr. Richard Burgi, PE, City of Chico
FROM:	Mr. Harvey Oslick, PE, CFM, CPSWQ, EnvSP, Wood Rodgers, Inc.
	Mr. Michael Hughes, PE, Wood Rodgers, Inc.
DATE:	June 3, 2024
SUBJECT:	City of Chico and Butte County Levee Accreditation/Re-Accreditation Study

INTRODUCTION

The City of Chico (City) requested Wood Rodgers, Inc. (Wood Rodgers) to outline the process for accrediting/re-accrediting the State Plan of Flood Control (SPFC) levees that protect the City and ensure that the Federal Emergency Management Agency (FEMA) mapping is accurate when maps are updated as part of a FEMA Flood Insurance Study (FIS) update. In performing this work, Wood Rodgers has also considered the possible impacts of flooding to areas in Butte County that are within the proximity of the City's sphere of influence.

This Technical Memorandum (TM) summarizes the information reviewed that is related to the geotechnical aspects of the FEMA accreditation process, the data gaps identified, and the timeline and procedures to be followed for achieving accreditation/re-accreditation. As part of our review, Wood Rodgers also considered what measures will be needed to provide an Urban Levee of Flood Protection (ULOP) in accordance with California Department of Water Resources (DWR) Urban Levee Design Criteria (ULDC).

This TM also presents 100-year floodplain mapping based on levee removal in order to illustrate the potential floodplain that could be mapped by FEMA in the event that FEMA decided to de-accredit the levees and prepare mapping based on the hydrology documented in the City's Draft Storm Water Master Plan (Draft SWMP).

Refer to **Figure 1** for the location of SPFC levees that have been reviewed as part of this study.

BACKGROUND

The SPFC levees that provide protection to the City and adjacent areas in Butte County include:

- <u>Right bank[1] of Mud Creek from approximately Levee Mile (LM[2]) 2 to LM 7.3</u>
  This levee segment is maintained by Butte County Public Works and has the reference number NA 3 Unit 1.
- <u>Left bank of Mud Creek from approximately LM 0.0 to LM 4.8</u>
  This levee segment is maintained by Butte County Public Works and has the reference number NA 3 Unit 2.
- <u>Right bank of Sycamore Creek from approximately LM 0.0 to LM 4.2</u>

[1] *Left bank and right bank refer to levee locations looking in a downstream direction.*
[2] *Levee miles per DWR Operations and Maintenance Manuals are different than the HEC-RAS River Miles.*

This levee segment is maintained by Butte County Public Works and has the reference number NA 3 Unit 3. This section includes the left and right banks of Sheep Hollow Creek.

- Left bank of Sycamore Creek from approximately LM 0.0 to LM 2.9
  This levee segment is maintained by Butte County Public Works and has the reference number NA 3 Unit 4. This section includes the left and right banks of Dry Creek.
- Left bank of Sycamore Creek Diversion Channel from approximately LM 0.0 to LM 1.9
  This levee segment is maintained by Butte County Public Works and has the reference number NA 3 Unit 5.
- Left bank of Butte Creek from approximately LM 0.0 to LM 1.5
  This levee segment is maintained by DWR Sutter Yard (Maintenance Area No. 5) and has the reference number MA 5 Unit 1.
- Right bank of Butte Creek from approximately LM 13.6 to LM 16.5
  This levee segment is maintained by DWR Sutter Yard (Maintenance Area No. 5) and has the reference number MA 5 Unit 2.
- Right bank of Little Chico Diversion Channel from approximately LM 0.0 to LM 1.5
  This levee segment is maintained by DWR Sutter Yard (Maintenance Area No. 5) and has the reference number MA 5 Unit 3.

Portions of these levee systems are currently accredited by FEMA (generally the left bank (south) of the levee along Sycamore Creek and the left bank (east) of the levee along Mud Creek), while the remainder are not accredited. FEMA may de-accredit a levee under some circumstances or request documentation to verify continuing accreditation. The levee owners are required to certify (or re-certify) levees to be accredited during a FEMA FIS update.

DOCUMENTATION REVIEWED

The following documents were reviewed by Wood Rodgers as part of the accreditation/re-accreditation assessment.

***Draft Provisionally Accredited Levee (PAL) Report*, Lumos and Associates, December 13, 2010 (Lumos, 2010).**

This draft report presents information to demonstrate the south (left bank) levees of Sycamore Creek and Mud Creek meet the requirements of Title 44 Code of Federal Regulations (CFR) § 65.10. Specific portions of the levees evaluated included:

- Left bank of the Diversion Channel and Sycamore Creek located east of Cohasset Road;
- Left bank of Sycamore Creek located west of Cohasset Road, extending to its confluence with Mud Creek; and
- Left bank of Mud Creek, extending from high ground downstream to State Route 32 (SR 32).

***Sycamore and Mud Creeks Provisionally Accredited Levee (PAL) Report*, Lumos and Associates, January 27, 2011 (Lumos, 2011).**

This report is the final draft of a portion of the December 2010 PAL Report covering the following specific requirements of 44 CFR § 65.10:

- 44 CFR § 65.10 (b)(3) Embankment Protection
- 44 CFR § 65.10 (b)(4) Embankment and Foundation Stability
- 44 CFR § 65.10 (b)(5) Settlement
- 44 CFR § 65.10 (b)(6) Interior Drainage

FEMA Accreditation Letter, Sycamore-Mud Creek Levee System Segment, May 12, 2011 (FEMA, 2011)

This FEMA Accreditation Letter stated that, based on the information submitted by the City, the south side of the Sycamore-Mud Creek Levee System (Levee ID Nos. 1164, 1173, 1243, 1244, 1278, 1304, 1306, and 1308) meets the minimum certification criteria outlined in 44 CFR 65.10 and provides protection from the 1-percent annual exceedance (base) flood.

***Provisionally Accredited Levee (PAL) Report for Mud Creek Levee System Northwesterly Banks FEMA Levee #1034 & #1256*, Lumos and Associates, July 2015 (Lumos, 2015).**

This PAL Report presents information related to the northwestern (right bank) levees of the Mud Creek Levee System and conformance to the requirements of 44 CFR § 65.10, specifically 65.10 (b)(3), (b)(4), (b)(5), and (b)(6). Portions of the levees evaluated included:

- 1,500’ $^{+}/_{-}$ southwesterly of Hicks Lane to the confluence with Sycamore Creek (ID #1256);
- Confluence with Sycamore Creek to SR 32 (ID #1034); and
- SR 32 to 1,500’ $^{+}/_{-}$ southwesterly of Meridian Road (ID #1034)

***Geotechnical Data Report (Volume 10)*, Chico Study Area, Non-Urban Levee Evaluation (NULE) Program, URS, November 2012 (URS, 2012).**

This report summarizes geotechnical data collected during DWR’s Non-Urban Levee Evaluation (NULE) Phase 2 geotechnical explorations for the Chico Study Area in Butte and Glenn Counties, California. The Chico Study Area includes non-urban Project Levee Segments 45 (Mud Creek), 274 (Little Chico Creek Diversion Channel), 263 (Butte Creek, right bank), 104 (Butte Creek right bank), and 381 (Butte Creek, left bank). These levee segments relate to the following study area levee locations:

> **Levee Segment 45** – Segment 45 is located on the right (west) bank of Mud Creek. This segment extends from approximately 0.8 mile east of the intersection of Dusty Lane and Gail Court, towards the southwest, to approximately 1.0 mile southwest of the intersection of West Sacramento Avenue and Meridian Road.
>
> **Levee Segment 274** – Segment 274 is located on the right (west) bank of the Little Chico Creek-Butte Creek Diversion Channel in Butte County. The segment extends from the Little Chico Creek Diversion Structure downstream, along the Little Chico Creek Diversion Channel approximately 2.9 miles to the

confluence of the diversion channel and Butte Creek, and approximately 0.3 mile from there along Butte Creek to SR 99. The segment was broken into Reach 1 and Reach 2 based on the availability of 1955 and 1957 water surface elevations.

Levee Segment 263 – Segment 263 is located on the right (west) bank of Butte Creek in Butte County. The segment extends from SR 99 downstream approximately 6.6 miles to Midway Road.

Levee Segment 104 – Segment 104 is located on the west (right) bank of Butte Creek in Colusa and Glenn Counties. The southern portion of the segment from approximately LM 0.0.00 to LM 1.65 is in Glenn County, and the remainder of the segment is in Colusa County. The segment extends from Midway Road to approximately 1 mile west of Aguas Frias Road.

Levee Segment 381 – Segment 381 is located on the left (east) bank of the Butte Creek in Butte County. The segment extends from approximately 0.3 mile upstream of SR 99 downstream approximately 7.1 miles to Midway Road.

Geotechnical Overview Report (GOR) Volume 1, Existing Conditions (Volume 1) Chico North and South Study Area Levee Segments 104, 263, 274, 381, and 45, NULE Program, URS, August 2014 (URS, 2014).

The report presents the results of geotechnical analyses for the stated levee segments, including steady-state seepage, landside slope stability, and waterside rapid drawdown slope stability.

Geotechnical Data Report, Chico North Study Area, Urban Levee Evaluation (ULE) Program, URS, October 2010 (URS, 2010)

This report summarizes geotechnical data and performance information collected during DWR's Urban Levee Evaluation Program (ULE) for the Chico area levees, including portions of the left banks of Sycamore, Mud, and Dry Creeks, and the Sycamore Creek Diversion Channel.

Specific areas covered include:

Sycamore Creek – the left bank of Sycamore Creek from the confluence with Mud Creek to approximately 2.1 miles east.

Mud Creek – the left bank of Mud Creek from the confluence with Sycamore Creek to approximately 2.65 miles south to Union Pacific Railroad.

Dry Creek – the left and right banks of Dry Creek from the confluence of Sycamore Creek to approximately 0.26 mile and 0.43 mile southeast, respectively.

Sycamore Creek Diversion Channel – the left bank of the diversion channel from Lindo Channel in the east to approximately 1.4 miles northwest, where it merges with high ground.

Geotechnical Evaluation Report, Chico North Study Area, ULE Program, URS, March 2015 (URS, 2015).

The report presents the results of analyses for Chico North Study Area levees, including freeboard, erosion, steady-state seepage, landside slope stability, and waterside rapid drawdown slope stability.

Standard Operating Procedure (SOP) 3, Geotechnical Levee Evaluation, United States Corp of Engineers (USACE), Sacramento District Geotechnical Engineer Branch, May 2022 (USACE, 2022).

This document presents geotechnical guidelines for levee evaluation, analysis, design, construction and the maintenance of levees in accordance with Sacramento District and USACE guidance and regulations. This document, together with USACE's *EM 1110-2-1913 Design and Construction of Levees* and DWR's *Guidance Document for Geotechnical Analysis*, are the main reference documents for levee evaluation, analysis, and design in the Sacramento Valley and have been used to assess the relevance and adequacy of existing geotechnical information per levee segment.

In accordance with SOP 3: *"Explorations should extend to a depth of at least four times the levee height into the levee foundation or to the bottom of the any aquifer that may be influencing levee performance. To evaluate stability and settlement, extend explorations to an appropriate stratum. Exploration depths in the range of 60 to 120 ft will be common"*. For design purposes: *"Explorations should generally be located as a triplet of explorations on 500 ft horizontal spacing along the waterside toe, levee crown, landside toe. Waterside borings may be omitting if site conditions prevent access, such as waterside channels immediately adjacent to the levee, and these explorations may be shifted to the landside. Additional borings may be performed landward and waterward of the levee (100 to 500 ft away from the levee) to evaluate the distal seepage condition.*"

FINDINGS OF DOCUMENTATION REVIEW

Based on the documentation reviewed, the following geotechnical information was identified:

RIGHT BANK OF MUD CREEK, LM 2 TO LM 7.29 (NA 3 UNIT 1)

This approximately 5.3-mile section of levee was the subject of a study made between 2012 and 2015 by Lumos and Associates on behalf of Butte County Public Works (Lumos, 2015). As part of this study, eight borings were completed to depths of between 36.5 feet and 46.5 feet below the crown of the levee. Two of the borings were completed in the section of levee located upstream of the confluence with Sycamore Creek.

The Lumos Study concluded that the levee met FEMA standards for Embankment Protection, Embankment and Foundation Stability, and Settlement. However, design standards for levee evaluation have changed since the completion of this study, and Wood Rodgers considers that the information presented and the analysis performed as part of the study are not sufficient from a current FEMA accreditation perspective.

The section of levee upstream of the confluence with Sycamore Creek was also studied as part of DWR's NULE Program (URS, 2012 and URS, 2014). A total of four borings were completed to depths of between 42 to 47 feet below the levee crown. Five cone penetration test soundings were also completed to depths of up to 22 feet below the levee crown. This feasibility-level study concluded that portions of the levee did not meet embankment stability and seepage criteria for the assessment water surface elevation used[3].

Additional borings were conducted by USACE as part of the original design (circa 1960), but the location and the accuracy of this data is uncertain and, therefore, not considered reliable for the purpose of this assessment.

Based on USACE's SOP 3 (USACE, 2022), the number of explorations needed to meet current investigation and design standards for the section of Mud Creek upstream of the confluence with Sycamore Creek (LM 5.5 to LM 7.3) is estimated to be 60. In this case, approximately 50 additional explorations to depths of between 50 and 60 feet below the levee crown are needed to support seepage and stability analysis as part of the FEMA and ULOP accreditation processes.

For the section of Mud Creek downstream of the confluence with Sycamore Creek (LM 2 to LM 5.5), it is estimated that approximately 110 explorations would be required to meet current design standards. As a result, approximately 104 additional explorations to depths of between 50 and 60 feet below the levee crown are needed to support a seepage and stability analysis as part of the FEMA and ULOP accreditation processes.

LEFT BANK OF MUD CREEK, LM 0.0 TO LM 4.8 (NA 3 UNIT 2)

The section of levee located downstream of the confluence with Sycamore Creek between approximately LM 1.4 and LM 4.8 was part of a study done between 2010 and 2011 by Lumos and Associates on behalf of the City of Chico (Lumos, 2010, and Lumos 2011). The study utilized explorations completed by DWR as part of the Chico North investigation (URS, 2010). A total of fourteen explorations were completed to depths of between 31.5 feet and 40 feet below the crown of the levee.

The Lumos Study concluded that the levee met FEMA standards for Embankment Protection, Embankment and Foundation Stability, and Settlement. However, design standards for levee evaluation have changed since the completion of this study and Wood Rodgers considers the information presented and the analysis that was performed as part of the study are not sufficient from a current FEMA accreditation perspective.

The section of levee downstream of the confluence with Sycamore Creek between approximately LM 1.4 and LM 3.8 was also studied as part of the DWR ULE Program (URS, 2010, and URS, 2015). This feasibility-level study concluded that the levee met embankment stability and seepage criteria for the 200-year water surface elevation.

Additional borings were conducted by USACE as part of the original design (circa 1960), but the location and accuracy of this data is uncertain and not considered reliable for the purpose of this assessment.

No geotechnical information was identified for the section of levee upstream of the confluence with Sycamore Creek between approximately LM 0.0 and LM 1.4

Based on USACE's SOP 3 (USACE, 2022), the number of explorations needed to meet current investigation and design standards for the section of Mud Creek between LM 0.0 and LM 4.8 is

[3] *The 1955/57 design water surface elevation was used for assessment as part of the DWR NULE Chico North and South Study Area (URS, 2014).*

estimated to be 155. As a result, approximately 141 additional explorations to depths of between 50 and 60 feet below the levee crown are needed to support a seepage and stability analysis as part of the FEMA and ULOP accreditation processes.

RIGHT BANK OF SYCAMORE CREEK, LM 0.0 TO LM 4.2 (NA 3 UNIT 3)

The section of levee along the right bank of Sycamore Creek between LM 0.0 and LM 4.2, including the right and left banks of Sheep Hollow Creek, do not appear to have been studied and recent geotechnical explorations are not available.

Based on USACE's SOP 3 (USACE, 2022), the number of explorations needed to meet current investigation and design standards for this section of Sycamore Creek are estimated to be 136.

LEFT BANK OF SYCAMORE CREEK, LM 0.0 TO LM 2.9 (NA 3 UNIT 4)

The section of levee upstream of the confluence with Mud Creek (excluding the left and right banks of Dry Creek) was part of a study between 2010 and 2011 by Lumos and Associates on behalf of the City of Chico (Lumos, 2010, and Lumos 2011). The study utilized explorations completed by DWR as part of the Chico North investigation (URS, 2010). A total of twelve explorations were completed to depths of between 17 feet and 36.5 feet below the crown of the levee.

The Lumos Study concluded that the levee met FEMA standards for Embankment Protection, Embankment and Foundation Stability, and Settlement. However, design standards for levee evaluation have changed since the completion of that study, and Wood Rodgers considers the information presented and analysis performed as part of the study are not sufficient from a current FEMA accreditation perspective.

This section of levee was also studied as part of the DWR ULE Program (URS, 2010, and URS, 2015). This feasibility-level study concluded that the levee met embankment stability and seepage criteria for the 200-year water surface elevation.

Additional borings were conducted by USACE as part of the original design (circa 1960), but the location and accuracy of this data is uncertain and not considered reliable for the purpose of this assessment.

Based on USACE's SOP 3 (USACE, 2022), the number of explorations needed to meet current investigation and design standards for this section of Sycamore Creek is estimated to be 95. As a result, approximately 83 additional explorations to depths of between 50 and 60 feet below the levee crown are needed to support a seepage and stability analysis as part of the FEMA and ULOP accreditation processes.

LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0.0 TO LM 1.85 (NA 3 UNIT 5)

This section of levee was part of a study made between 2010 and 2011 by Lumos and Associates on behalf of the City of Chico (Lumos, 2010, and Lumos 2011). The study utilized explorations completed by DWR as part of the Chico North investigation (URS, 2010). A total of two explorations were completed to depths of between 17 feet and 46 feet below the crown of the levee.

The Lumos Study concluded that the levee met FEMA standards for Embankment Protection, Embankment and Foundation Stability, and Settlement. However, design standards for levee evaluation have changed since the completion of this study, and Wood Rodgers considers the information presented and the analysis performed as part of the study are not sufficient from a current FEMA accreditation perspective.

This section of levee was also studied as part of the DWR ULE Program (URS, 2010, and URS, 2015). This feasibility-level study concluded that the levee met embankment stability and seepage criteria for the 200-year water surface elevation.

Based on USACE's SOP 3 (USACE, 2022), the number of explorations needed to meet current investigation and design standards for this section of Sycamore Creek is estimated to be 62. As a result, approximately 60 additional explorations to depths of between 50 and 60 feet below the levee crown are needed to support a seepage and stability analysis as part of the FEMA and ULOP accreditation processes.

LEFT BANK OF BUTTE CREEK, LM 0.0 TO LM 1.5 (MA 5 UNIT 1)

This section of levee was studied as part of the DWR NULE Program (URS, 2012 and URS, 2014). A total of eleven explorations were completed to depths of between 18 and 57 feet below the levee crown. This feasibility-level study concluded that portions of the levee did not meet embankment stability and seepage criteria for the assessment water surface elevation used.

Based on USACE's SOP 3 (USACE, 2022), the number of explorations needed to meet current investigation and design standards for this section of Sycamore Creek is estimated to be 51. As a result, approximately 40 additional explorations to depths of between 50 and 60 feet below the levee crown are needed to support a seepage and stability analysis as part of the FEMA and ULOP accreditation processes.

RIGHT BANK OF BUTTE CREEK, LM 13.6 TO LM 16.5 (MA 5 UNIT 2)

This section of levee was studied as part of the DWR NULE Program (URS, 2012 and URS, 2014). A total of sixteen explorations were completed to depths of between 2 and 61 feet below the levee crown. This feasibility-level study concluded that the levee met embankment stability and seepage criteria for the assessment water surface elevation used.

Based on USACE's SOP 3 (USACE, 2022), the number of explorations needed to meet current investigation and design standards for this section of Sycamore Creek is estimated to be 95. As a result, approximately 79 additional explorations to depths of between 50 and 60 feet below the levee crown are needed to support a seepage and stability analysis as part of the FEMA and ULOP accreditation processes.

RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0.0 TO LM 1.5 (MA 5 UNIT 3)

This section of levee was studied as part of DWRs NULE Program (URS, 2012 and URS, 2014). A total of two explorations were completed to depths of between 13 and 46 feet below the levee crown. This feasibility-level study concluded that the levee met embankment stability and seepage criteria for the assessment water surface elevation used.

Based on USACE's SOP 3 (USACE, 2022), the number of explorations needed to meet current investigation and design standards for this section of Sycamore Creek is estimated to be 51. As a result, approximately 49 additional explorations to depths of between 50 and 60 feet below the levee crown are needed to support a seepage and stability analysis as part of the FEMA and ULOP accreditation processes.

PROCEDURE FOR FEMA AND ULOP ACCREDITATION

Geotechnical tasks needed for accreditation include an additional subsurface investigation, laboratory testing, analysis, reporting, and design and construction of flood risk reduction measures to provide the necessary technical information to support FEMA (FEMA, 2011) and ULOP (DWR, 2013) accreditations.

In addition to geotechnically-related tasks, there is also a need for the involvement of other professional disciplines as part of the accreditation process. This includes civil, hydraulic, environmental, biological, and construction-related services.

The work and level of effort for achieving FEMA and ULOP accreditations is extensive, but the overall process is essentially the same from a planning perspective. The steps to be followed are briefly discussed under the following sub-sections and are summarized in **Figure 2.**

Data Gap Review and Preparation of a Drilling and Invasive Program Plan

Based on the documentation reviewed, each levee segment needs additional geotechnical explorations and laboratory testing data to meet current criteria. This work will involve exploration within the zone of influence of the levee prism and, therefore, requires an approved Drilling and Invasive Program Plan (DIPP) in accordance with USACE ER 1110-1-1807 (USACE, 2023).

As part of the permitting process for geotechnical investigation, USACE, as a federal agency, has an obligation to ensure the proposed work is consistent with the National Environmental Policy Act (NEPA) and would not result in undocumented environmental impacts.

At a minimum, USACE will require some level of biological habitat assessment to determine which federally protected species may be present, and to evaluate if the habitat present around the project area is suitable for those species. Levees are usually located in areas with high quality habitat associated with rivers and creeks so it's very common that this is an issue. Some species/plants can be avoided by moving a boring location, but some species cannot be fully avoided and require some level of consultation with the U. S. Fish and Wildlife Service (USFWS) to obtain clearance.

Levees are potentially a rich source of cultural artifacts based on where they are located and how they have been built from locally-sourced materials. Consultation with the USACE State Historic Preservation Officer and directly with local Native American tribal groups will be needed as part of the cultural resource approval process. Experience shows that inviting representatives from local tribes to monitor the borings, along with an archaeological monitor provided by either USACE or the project proponent, expedites the reporting and approval process.

The DIPP process can be very lengthy and can take over a year before an approved DIPP is acquired. The estimated cost for attaining an approved DIPP is presented in **Table 1** (attached).

Subsurface Investigation and Geotechnical Data Report

Field investigation work along the existing levee can proceed once an approved DIPP and associated permits have been obtained. The objective of the field investigation program will be to gather sufficient subsurface data to supplement existing information and to meet the needs of the current standard of care (USACE, 2022). A Geotechnical Data Report (GDR) will be prepared at the completion of the field investigation program to present all the information gathered during the investigation. It is possible that investigations will be conducted in a phased approach. The GDR should capture all phases of the investigation.

The duration for completion of the field investigation work and preparation of the GDR will vary depending on the number, depth, and type(s) of explorations required. Typically, a period of 8 to 12 months is sufficient to complete all fieldwork and laboratory testing and to finalize the GDR.

Although subsurface data has been collected for most of the levee segments, the amount of data collected is not sufficient to meet current standards (USACE, 2022) and, thus, additional investigation is required. The estimated cost of investigation is presented in Table 1.

Geotechnical Evaluation and Recommendations Report

As part of the evaluation process, geotechnical analysis is required to determine if a particular section of levee meets current standards for stability, seepage and erosion. The analysis process will take into consideration construction history, past performance, and the data presented in the GDR, which will be used to develop design criteria for geotechnical analysis. The results of analyses for stability, seepage, and erosion, as well as the results of other evaluations such as freeboard and levee geometry, will be presented in a Geotechnical Evaluation and Recommendations Report (GERR). For sections of levee not meeting current standards, additional analyses will be required to evaluate the flood risk reduction measures needed to meet current standards. The results of the analyses, the conclusion, and the recommendations will be presented in a Geotechnical Evaluations and Recommendations Report (GERR). A period of 12 months is typical for the finalization of a GERR. Analysis and preparation of the initial draft document can be done concurrently with the fieldwork phase, but they cannot be finalized until the GDR has been finalized.

Guidelines for geotechnical analysis are presented in the Guidance Document for Geotechnical Evaluation (DWR, 2015) and USACE's SOP 3 (USACE, 2022).

Although geotechnical analyses have been performed and documented for some of the levee segments, such analyses were based on limited geotechnical information; therefore, it should be assumed that GERRs will be needed for each levee segment. The estimated cost for the preparation of GERRs is presented in Table 1.

Construction Bid Package, Permitting, and Construction

Construction Bid Package

Following completion of a GERR, those sections of a levee segment deemed to be deficient will require the preparation of final plans, specifications, and construction cost estimates for the design of flood risk reduction measures necessary to bring substandard sections of levee up to standard. This process involves several phases of design development before the bid package is finalized (typically 35%, 65%, 95%, 100% and final) and requires interaction among multiple disciplines, including but not limited to civil, hydraulic, environmental, biological, and construction related services. The whole process takes at least 1.5 years to complete and can be longer for larger levee segments.

The exact extent of design deficiencies for levee segments reviewed as part of this study are not currently known because GERRs have not been prepared. As such, aside from freeboard deficiencies, it is uncertain how many levee segments will need construction of new flood risk reduction measures.

Permitting

Environmental support for permitting is a large component of the work. A NEPA document will be needed for the proposed levee improvements. This document needs to cover a wide range of potential environmental impacts and usually the preparation of environmental technical studies is the first step, including:

- Cultural Resources Inventory Report
- Biological Resources Report
- Aquatic Resources Delineation Report
- Air Quality Report and GHG Emissions Analysis (construction activities only)
- Community Impact Assessment (may include noise impacts, ROW impacts, etc.)
- Visual Impact Assessment
- Traffic Impact Assessment (haul routes, fixing local roads damaged during construction, etc.)

Information gathered from the tasks in the above bullets inform preparation of the NEPA document. For major levee improvement projects this will typically be either an Environmental Assessment (EA) leading to a Finding of No Significant Impact (FONSI), or an Environmental Impact Statement. Both documents provide a comprehensive public outreach process, an opportunity for public comments, and should evaluate multiple alternatives (if feasible). The NEPA document will also need to be adapted to satisfy a separate California Environmental Quality Act document.

Further interagency coordination, building on the work from the DIPP process, will likely be needed for Section 106 of the National Historic Preservation Act and/or Section 7 of the Endangered Species Act. USACE would coordinate with the State Historic Preservation Officer for the former, and with the US Fish and Wildlife Service or National Marine Fisheries Service for the latter. Major rivers often provide habitat for spawning fish like salmon and steelhead so any vegetation removal around the river is considered a major impact to those fish that migrate up these rivers. This process often takes many months of back-and-forth coordination between the federal agencies.

Lastly, other environmental permits are often required if the project involves direct impacts to Waters of the State or Waters of the US. These permits most often include some or all of the following:

- USACE 404 Fill Permit
- USACE 408 Permit
- Regional Water Quality Control Board – 401 Water Quality Certification
- California Department of Fish and Wildlife – 1602 Streambed Alteration Agreement
- California Department of Fish and Wildlife – 2081 Incidental Take Permit
- Central Valley Flood Protection Board (CVFPB) – Encroachment Permit

Environmental support and coordination for permitting can take up to 2 years and sometimes longer depending on the complexity of the project. The estimated cost for environmental support and coordination during the permitting phase has been captured as part of the preparation of the construction bid package and is included in **Table 2A and 2B**.

Construction

Once the construction bid package has been finalized and all permits are in hand, the project can be bid for construction. The project proponent will need support during the bid process to respond to potential bidder questions and select a qualified, lowest cost bidder. The construction window for flood risk reduction projects that involve work within existing floodways, including existing levees, is constrained by the flood season as identified by the CVFPB and typically spans from mid-April to mid-October.

Narrowing of this construction window can occur if sensitive species and/or nesting birds are located within the work area. As such, construction often spans multiple construction seasons.

Estimated costs for construction of earthworks to address freeboard and levee geometry issues are presented in **Table 3A and 3B** for the 100-year water surface elevation and 200-year water surface elevation respectively. Estimated costs for construction for seepage and/or stability issues are captured in **Table 4A and 4B** and assumes that construction costs would include work to address freeboard and geometry deficiencies. That is, costs in **Tables 3A and 4A** and **3B and 4B** are not cumulative.

Prepare of As-Built Drawings and Updates to the Operation and Maintenance Manual

Following completion of construction, as-built drawings will need to be prepared to capture the actual project elements constructed. Also, the maintenance manual will need to be updated to cover the flood risk reduction improvements. The cost for this work is estimated to be around $100k regardless of the length of the levee segments under consideration.

Once these items are in place, the project proponent should have all the necessary information to be able to proceed with accreditation. The accreditation process requires the compilation of all design and construction documentation into a summary report, signed by a licensed Civil Engineer. Further details on FEMA and ULOP accreditation are provided in the following sections.

Estimated costs for the preparation of Engineers Summary Reports for FEMA and ULOP accreditation are presented in Table 6.

FEMA ACCREDITATION

The provisions of Title 44 of the Code of Federal Regulations Section 65.10 (44 CFR § 65.10) stipulate the information, technical evaluations, and certificates needed by FEMA to obtain accreditation and for them to recognize, on National Flood Insurance Protection Maps, that a levee system provides protection from the base flood. Specifically, 44 CFR § 65.10 (b), Design Criteria, presents the criteria that must be met, these being:

Freeboard [44 CFR § 65.10(b)(1)]

In accordance with the 44 CFR § 65.10(b)(1):

i. *"Riverine levees must provide a minimum freeboard of three feet above the water surface level of the base flood. An additional one foot above the minimum is required within 100 feet on either side of structures (such as bridges) riverward of the levee, or wherever the flow is constricted. An additional one-half foot above the minimum at the upstream end of the levee, tapering to not less than the minimum at the downstream end of the levee, is also required.*

ii. *Occasionally, exceptions to the minimum riverine freeboard requirement described in paragraph (b)(1)(i) of this section, may be approved. Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted to support a request for such an exception. The material presented must evaluate the uncertainty in the estimated base flood elevation profile and include, but not necessarily be limited to, an assessment of statistical confidence limits of the 100-year discharge; changes in stage-discharge relationships; and the sources, potential and magnitude of debris, sediment, and ice accumulation. It must be also shown that the levee will remain structurally stable during the base flood when such additional loading considerations are imposed. Under no circumstances will freeboard of less than two feet be accepted."*

Closures [44 CFR § 65.10(b)(2)]

In accordance with 44 CFR § 65.10(b)(2):

> *"All openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice."*

Embankment Protection [44 CFR § 65.10(b)(3)]

In accordance with the 44 CFR § 65.10(b)(3):

> *"Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability. The factors to be addressed in such analyses include, but are not limited to: Expected flow velocities (especially in constricted areas); expected wind and wave action; ice loading; impact of debris; slope protection techniques; duration of flooding at various stages and velocities; embankment and foundation materials; levee alignment, bends, and transitions; and levee side slopes."*

Embankment and Foundation Stability [44 CFR § 65.10(b)(4)]

In accordance with the 44 CFR § 65.10(b)(4):

> *"Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined in the U.S. Army Corps of Engineers (COE) manual, "Design and Construction of Levees" (EM 1110-2-1913, Chapter 6, Section II), may be used. The factors that shall be addressed in the analyses include: Depth of flooding, duration of loading, embankment geometry and length of seepage path at critical locations, embankment and foundation materials, embankment compaction, penetrations, other design factors affecting seepage (such as drainage layers), and other design factors affecting embankment and foundation stability (such as berms)."*

Settlement [44 CFR § 65.10(b)(5)]

In accordance with 44 CFR § 65.10(b)(5):

> *"Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained within the minimum standards set forth in paragraph (b)(1) of this section. This analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in the COE manual, "Soil Mechanics Design – Settlement Analysis" (EM 1110-2-1904) must be submitted."*

Interior Drainage [44 CFR § 65.10(b)(6)]

In accordance with 44 CFR § 65.10 (b)(6):

"An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than one foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters."

Other Criteria [44 CFR § 65.10(b)(7)]

In accordance with 44 CFR § 65.10 (b)(7):

"In unique situations, such as those where the levee system has relatively high vulnerability, FEMA may require that other design criteria and analyses be sub-mitted to show that the levees provide adequate protection. In such situations, sound engineering practice will be the standard on which FEMA will base its determinations. FEMA will also provide the rationale for requiring this additional information."

Operations Plans and Criteria [44 CFR § 65.10(c)]

Regulations regarding operation plans and criteria required by FEMA are covered in 44 CFR § 65.10(c). This section states the following:

"Operation plans and criteria. For a levee system to be recognized, the operational criteria must be as described below. All closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought or when the manual for a previously recognized system is revised in any manner. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP."

Closures [44 CFR § 65.10(c)(1)]

In accordance with 44 CFR § 65.10(c)(1) operation plans for closures must include:

i. *"Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.*
ii. *A formal plan of operation including specific actions and assignments of responsibility by individual name or title.*
iii. *Provisions for periodic operation, at not less than one-year intervals, of the closure structure for testing and training purposes."*

Interior Drainage Systems [44 CFR § 65.10 (c)(2)]

In accordance with 44 CFR § 65.10(c)(2):

"Interior drainage systems. Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood protection purposes only if the following minimum criteria are included in the operation plan:

i. *Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that* *sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.*

ii. *A formal plan of operation including specific actions and assignments of responsibility by individual name or title.*

iii. *Provision for manual backup for the activation of automatic systems.*

iv. *Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than one year shall elapse between either the inspections or the operations."*

Other Operation Plans and Criteria [44 CFR § 65.10(c)(3)]

Section 44 CFR § 65.10(c)(3) provides for the operation plan to include:

"Other operation plans and criteria. Other operating plans and criteria may be required by FEMA to ensure that adequate protection is provided in specific situations. In such cases, sound emergency management practice will be the standard upon which FEMA determinations will be based."

Maintenance Plans and Criteria [44 CFR § 65.10(d)]

General Maintenance Protocol

Section 44 CFR § 65.10(d) contains regulatory requirements for maintenance plans and criteria. This section states:

"Maintenance plans and criteria. For levee systems to be recognized as providing protection from the base flood, the maintenance criteria must be as described herein. Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner. All maintenance activities must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance. This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, maintenance plans shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance."

Certification Requirements [44 CFR § 65.10(d)]

In accordance with 44 CFR § 65.10 (d):

"Data submitted to support that a given levee system complies with the structural requirements set forth in paragraphs (b)(1) through (7) of this section must be certified by a registered professional engineer. Also, certified as-built plans of the levee must be submitted. Certifications are subject to the definition given at §65.2 of this subchapter. In lieu of these structural requirements, a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection against the base flood."

ULOP ACCREDITATION

The California Legislature passed Senate Bill 5 (SB 5) in 2007, requiring all new projects or reconstruction projects constructed in urban areas[4] within the Sacramento-San Joaquin Valley to achieve an urban level of flood protection by 2025. An urban level of flood protection is defined as the level of flood protection necessary to withstand flooding that has a 1-in-200 chance of occurring in any given year.

Senate Bill 5 also authorized the DWR to develop criteria for an urban level of flood protection. In May 2012, DWR issued the Urban Levee Design Criteria (ULDC) (DWR, 2012), that provides technical criteria for designing, constructing, operating, and maintaining a levee or floodwall for protection against a flood with a 1-in-200 annual chance of occurrence (i.e., a 200-year flood). In November 2013, DWR issued ULOP criteria (DWR, 2013), which are procedural criteria for developing findings related to 200-year flood protection.

In accordance with ULDC criteria the following items need to be addressed:

1. Design Water Surface Elevation (ULDC Section 7.1)
2. Minimum Top-of-Levee (ULDC Section 7.2)
3. Soil Sampling, Testing and Logging (ULDC Section 7.3)
4. Slope Stability for Intermittently Loaded Levees (ULDC Section 7.4)
5. Under-Seepage for Intermittently Loaded Levees (ULDC Section 7.5)
6. Frequently Loaded Levees (ULDC Section 7.6)
7. Seismic Vulnerability (ULDC Section 7.7)
8. Levee Geometry (ULDC Section 7.8)
9. Interfaces and Transitions (ULDC Section 7.9)
10. Erosion (ULDC Section 7.10)
11. Right-of-Way (ULDC Section 7.11)
12. Encroachments (Excluding Penetrations, Closure Structures, and Levee Vegetation) (ULDC Section 7.12)
13. Penetrations (ULDC Section 7.13)
14. Floodwalls, Retaining Walls, and Closure Structures (ULDC Section 7.14)
15. Animal Burrows (ULDC Section 7.15)
16. Levee Vegetation (ULDC Section 7.16)
17. Wind Setup and Wave Run-up (ULDC Section 7.17)
18. Security (ULDC Section 7.18)
19. Sea Level Rise (ULDC Section 7.19)
20. Emergency Actions (ULDC Section 7.20)

[4] *"Urban area" is defined as a developed area in which there are 10,000 residents or more.*

21. Operations, Maintenance, Inspection, Monitoring, and Remediation of Poor Performance (ULDC Section 8.0)

To obtain ULOP (DWR, 2013) accreditation, an agency needs to prepare an Engineers Report showing compliance with the above ULDC (DWR, 2012) criteria and presenting certifications in accordance with the requirements, definitions, and descriptions in DWRs ULOP (DWR, 2013), Section 2, Subsection *EVD-3*.

FLOODPLAIN MAPPING & LEVEE FREEBOARD DEFICIENCY EVALUATION

Floodplain mapping was prepared in order to provide an estimate of 100-year floodplain could be expected if FEMA were to remap the City of Chico based on the currently accredited levees being de-accredited. Details about the HEC-RAS model development and flow rates are presented in the *Storm Water Master Plan* (Draft). The model runs to prepare the 100-year flood mapping were to develop to evaluate results based on the removal of one level segment at a time. There were approximately 100 separate runs based on various segments being removed to define the composite floodplain. In some cases, multiple independent levee segments removals were evaluated simultaneously such that independent levees were located on the Mud Creek and Butte Creek systems. The lateral structure weir elevations were adjusted based on the terrain toe elevations for each levee segment. This approach is intended to provide a floodplain map that would be developed by FEMA as if the currently accredited levees were not accredited. The results show differences in floodplains associated with levees that are not currently accredited due to new hydrology and improved hydraulic modeling. The composite floodplain results are presented on **Figure 3**. Figure 3 uses randomly generated colors to illustrate the various levee segments that were removed to prepare the floodplain map.

Separate HEC-RAS model runs were prepared to compute levee height deficiencies. The separate model runs were used to compute profiles for the various flow rates associated with Areal Reduction Factors as described in the *Storm Water Master Plan*. Levee points were set in order to prevent overtopping flows from leaving the system. It was assumed that the 100-year and 200-year flows would be contained within Little Chico Creek Diversion Channel by channel expansion and vegetation maintenance, without the addition of new levees. The costs associated with this maintenance and channel expansion are not included in this memo. Deficiencies in freeboard for 100-year and 200-year flowrates were computed based on the water surface elevation minus an elevation three feet below the top of levee. The quantity of levee lengths with deficiencies between zero and one foot, one foot to two feet, and more than two feet were computed and used to estimate cost for implementing levee improvements. The locations of various levee height deficiencies for the 100-year and 200-year water surface profiles are presented in **Figures 4** and **5**, respectively.

CONCLUSIONS

Based on the documentation reviewed, additional subsurface investigation, laboratory testing, analysis, reporting, and design and construction of flood risk reduction measures are needed to provide the necessary technical information to support FEMA (FEMA, 2011) and ULOP (DWR, 2013) accreditation.

The cost for achieving accreditation is highly variable given the nature of the process and inherent differences between levee systems. Order of magnitude costs estimate[5] of the fees associated with the

[5] The costs estimates presented in this Technical Memorandum are very approximate and should be used as a guide only.

different aspects of the accreditation process, broken out by levee segment providing protection to the City and Butte County, are presented in **Table 1 through Table 7**.

Table 1 presents the estimated cost to complete the geotechnical tasks (data gathering [GDR], analysis and reporting [GERR]) needed to meet current standards (USACE, 2022).

Table 2A and Tables 2B present estimated design costs (preparation of plans, specifications, and cost estimates) for flood risk reduction measures (shallow cutoff wall/seepage berm) aimed at addressing seepage and/or stability deficiencies. Costs consider the findings of existing studies (**Table 2A**) where available, and also considers the potential that new studies based on additional site investigation data will find seepage and/or stability deficiencies in all levee segments (**Table 2B**).

Note that all studies conducted to date should be considered feasibility level studies and that the findings of more detailed studies conducted in accordance with the current standard of care may reach different conclusions. That is, previous levee segments found to meet standards may be found deficient.

Table 3A and 3B present the estimated cost to construct levee raises to address freeboard deficiencies for the 100-year water surface elevation and 200-year water surface elevation respectively.

Table 4A and 4B present the estimated cost to construct flood risk reduction measures (shallow cutoff wall/seepage berm) aimed at addressing seepage and/or stability deficiencies[6]. Costs consider findings of existing studies (**Table 4A**), where available, and also considers the potential that new studies based on additional site investigation data will find seepage and/or stability deficiencies in all levee segments (**Table 4B**).

Note that all studies conducted to date should be considered feasibility level studies and that the findings of more detailed studies conducted in accordance with the current standard of care may reach different conclusions. That is, previous levee segments found to meet standards may be found deficient.

Table 5 presents the estimated cost for the preparation of as-built plans and revision of the Operation and Maintenance Manual.

Table 6 presents the estimated cost to prepare the Engineers Summary Report for Accreditation.

Table 7 presents total costs for various levels of effort associated with achieving accreditation.

[6] Cost includes measures that would address freeboard and levee geometry issues as well. That is the costs from Tables 3A and 4A, and 3B and 4B, are not cumulative.

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ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
DWR	California Department of Water Resources
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
GOR	Geotechnical Overview Report
LM	Levee Mile
NFIP	National Flood Insurance Program
NULE	Non-Urban Levee Evaluation
PAL	Provisionally Accredited Levee
SOP	Standard Operating Procedure
SPFC	State Plan of Flood Control
SR	State Route
ULDC	Urban Levee Design Criteria
ULE	Urban Levee Evaluation
ULOP	Urban Levee of Flood Protection
URS	URS Corporation
USACE	United States Army Corps of Engineers

TABLES

TABLE 1 – Estimated Cost of Geotechnical Data Gathering, Analysis and Reporting

Levee Segment	Length (miles)	Number of Existing Explorations	Required Number of Borings per SOP 3	Number of Additional Explorations Required	Data Gap Review and DIPP[1]	Geotechnical Data Report[2]	Geotechnical Evaluation and Recommendations Report[3]	Total Estimated Level of Effort
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	11	114	103	$ 93,750	$ 2,057,600	$ 210,000	$ 2,361,350
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	6	60	54	$ 89,475	$ 1,074,144	$ 107,400	$ 1,271,019
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	4	51	47	$ 88,750	$ 930,400	$ 90,000	$ 1,109,150
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	10	108	98	$ 93,250	$ 1,950,880	$ 198,000	$ 2,242,130
RIGHT BANK OF SYCAMORE CREEK, LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	0	136	136	$ 95,500	$ 2,721,120	$ 252,000	$ 3,068,620
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	12	95	83	$ 92,250	$ 1,657,440	$ 174,000	$ 1,923,690
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	2	62	60	$ 89,625	$ 1,192,160	$ 111,000	$ 1,392,785
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	11	51	40	$ 88,750	$ 790,400	$ 90,000	$ 969,150
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	16	95	79	$ 92,250	$ 1,577,440	$ 174,000	$ 1,843,690
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	2	51	49	$ 88,750	$ 970,400	$ 90,000	$ 1,149,150

Notes: [1] Cost of data gap review and getting an approved Drilling and Invasive Program Plan assumes a base fee of $85,000, which includes $50,000 for environmental permitting support, plus an additional 10% for each mile of levee, or part thereof, over and above the first mile.

[2] Cost includes completion of necessary subsurface investigation to meet current USACE standards of triplet explorations at 500 feet spacing and assumes $20,000 per boring for exploration, laboratory testing, consultant labor, and reporting. It is possible that the number of explorations and overall cost of investigation could be reduced if it could be demonstrated that subsurface conditions are reasonably consistent based on the regional geomorphology of the area, thereby justifying a wider spacing between explorations.

[3] Cost assumes analysis and reporting fee of $60,000 per mile of levee.

TABLE 2A – Estimated Design Costs (Plans, Specifications, and Engineers Costs Estimate) Based on Findings of Existing Studies

Levee Segment	Length (miles)	Study	Stability	Seepage	Cost Estimate[1]
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	No Study/Not Studied to Current Standards	Assume Total Length Fails to Meet Criteria	Assume Total Length Fails to Meet Criteria	$ 3,750,000
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	Chico North and South Study Area, DWR NULE (URS, 2014)	Approx. 3,000 feet Fails to Meet Criteria	Approx. 3,000 feet Fails to Meet Criteria	$ 818,182
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	No Study/Not Studied to Current Standards	Assume Total Length Fails to Meet Criteria	Assume Total Length Fails to Meet Criteria	$ 1,750,000
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	Chico North Study Area, DWR ULE (URS, 2015)	Pass	Pass	$ -
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	No Study/Not Studied to Current Standards	Assume Total Length Fails to Meet Criteria	Assume Total Length Fails to Meet Criteria	$ 4,450,000
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	Chico North Study Area, DWR ULE (URS, 2015)	Pass	Pass	$ -
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	Chico North Study Area, DWR ULE (URS, 2015)	Pass	Pass	$ -
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	Chico North and South Study Area, DWR NULE (URS, 2014)	Approx. 1,432 feet Fails to Meet Criteria	Approx. 1,432 feet Fails to Meet Criteria	$ 521,212
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	Chico North and South Study Area, DWR NULE (URS, 2014)	Approx. 6,900 feet Fails to Meet Criteria	Approx. 6,900 feet Fails to Meet Criteria	$ 1,556,818
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	Chico North and South Study Area, DWR NULE (URS, 2014)	Pass	Pass	$ -

Notes: [1] Assumes design costs of $1M per mile of levee, excluding costs for geotechnical investigation, analyses, and reporting, which is captured in Table 1, plus a fee of $250k for environmental support and coordination.

TABLE 2B – Estimated Design Costs (Plans, Specifications, and Engineers Costs Estimate) Assuming All Levee Segments are Substandard		
Levee Segment	**Length (miles)**	**Cost Estimate[1]**
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	$ 3,750,000
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	$ 2,040,000
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	$ 1,750,000
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	$ 3,550,000
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	$ 4,450,000
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	$ 3,150,000
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	$ 2,100,000
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	$ 1,750,000
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	$ 3,150,000
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	$ 1,750,000

Notes: [1] Assumes design costs of $1M per mile of levee, excluding costs for geotechnical investigation, analyses, and reporting, which is captured in Table 1, plus a fee of $250k for environmental support and coordination.

TABLE 3A – Estimated Cost to Repair Freeboard Deficiencies for 100-Year Event [1]								
Levee Segment	**Levee Segment Length (miles)**	**Freeboard Deficiency of 0 to 1 feet (Length in feet)**	**Estimated Costs**	**Freeboard Deficiency of 1 to 2 feet (Length in feet)**	**Estimated Costs**	**Freeboard Deficiency of More than 2 feet (Length in feet)**	**Estimated Costs**	**Total Estimated Cost**
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	4,094	$1,226,959	1,109	$ 393,359	0	$ -	$1,620,318
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	1,451	$ 434,860	717	$ 254,318	0	$ -	$ 689,178
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	446	$ 133,665	166	$ 58,880	172	$ 73,908	$ 266,452
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	3,458	$1,036,352	969	$ 343,701	251	$ 107,854	$1,487,907
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	6,312	$1,891,687	2,581	$ 915,473	384	$ 165,004	$2,972,164
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	1,181	$ 353,942	0	$ -	0	$ -	$ 353,942
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	0	$ -	0	$ -	0	$ -	$ -
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	3,035	$ 909,580	1,757	$ 623,203	2,067	$ 888,184	$2,420,967
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	1,768	$ 529,864	2,925	$1,037,489	3,359	$1,443,352	$3,010,705
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	2,171	$ 650,642	927	$ 328,804	0	$ -	$ 979,446

Notes: [1] – Cost estimates based on a design cost of $0.5M per mile of freeboard raise, a unit rate per foot of levee length of $205, $260 and $335 for levee raises of 1 feet, 2 feet, and more than 2 feet respectively, and the following assumptions:

1. *Existing Levee Height = 7-ft*
2. *Existing Levee Crown Width = 12-ft*
3. *Existing Side Slopes = 3:1 waterside, 2:1 landside*
4. *Proposed Levee prism matches existing levee prism*
5. *Borrow Site Distance = within 10 miles*
6. *Land Acquisition/Environmental/Cultural/Utility Relocation costs are not included*

TABLE 3B – Estimated Cost to Repair Freeboard Deficiencies for 200-Year Event [1 & 2]

Levee Segment	Levee Segment Length (miles)	Freeboard Deficiency of 0 to 1 feet (Length in feet)	Estimated Costs	Freeboard Deficiency of 1 to 2 feet (Length in feet)	Estimated Costs	Freeboard Deficiency of More than 2 feet (Length in feet)	Estimated Costs	Total Estimated Cost
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	1,115	$ 334,162	3,410	$1,209,517	2,228	$ 957,365	$2,501,044
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	929	$ 278,418	1,403	$ 497,640	91	$ 39,102	$ 815,161
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	799	$ 239,458	194	$ 68,811	172	$ 73,908	$ 382,177
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	1,005	$ 301,195	2,816	$ 998,827	2,069	$ 889,043	$2,189,065
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	7,323	$2,194,681	5,764	$2,044,473	1,328	$ 570,638	$4,809,792
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	7,781	$2,331,942	119	$ 42,209	0	$ -	$2,374,151
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	0	$ -	0	$ -	0	$ -	$ -
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	386	$ 115,683	2,891	$1,025,429	4,091	$1,757,890	$2,899,002
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	295	$ 88,411	1,377	$ 488,418	6,732	$2,892,720	$3,469,548
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	1,310	$ 392,603	3,702	$1,313,088	1,034	$ 444,307	$2,149,998

Notes: [1] – Cost estimates based on a design cost of $0.5M per mile of freeboard raise, a unit rate per foot of levee length of $205, $260 and $335 for levee raises of 1 feet, 2 feet, and more than 2 feet respectively, and the following assumptions

1. *Existing Levee Height = 7-ft*
2. *Existing Levee Crown Width = 12-ft*
3. *Existing Side Slopes = 3:1 waterside, 2:1 landside*
4. *Proposed Levee prism matches existing levee prism*
5. *Borrow Site Distance = within 10 miles*
6. *Land Acquisition/Environmental/Cultural/Utility Relocation costs are not included*

[2] – Estimated costs also include lengths of levee segments with 100-year Freeboard Deficiency

TABLE 4A – Estimated Cost to Repair Seepage and/or Stability Deficiencies Based on Existing Studies[1]

Levee Segment	Length (miles)	Study	Stability	Seepage	Lower Bound Cost Estimate[2]	Upper Bound Cost Estimate[3]
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	No Study/Not Studied to Current Standards	Assume Total Length Fails to Meet Criteria	Assume Total Length Fails to Meet Criteria	$ 43,750,000	$ 61,250,000
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	Chico North and South Study Area, DWR NULE (URS, 2014)	Approx. 3,000 feet Fails to Meet Criteria	Approx. 3,000 feet Fails to Meet Criteria	$ 7,102,273	$ 9,943,182
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	No Study/Not Studied to Current Standards	Assume Total Length Fails to Meet Criteria	Assume Total Length Fails to Meet Criteria	$ 18,750,000	$ 26,250,000
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	Chico North Study Area, DWR ULE (URS, 2015)	Pass	Pass	$ -	$ -
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	No Study/Not Studied to Current Standards	Assume Total Length Fails to Meet Criteria	Assume Total Length Fails to Meet Criteria	$ 52,500,000	$ 73,500,000
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	Chico North Study Area, DWR ULE (URS, 2015)	Pass	Pass	$ -	$ -
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	Chico North Study Area, DWR ULE (URS, 2015)	Pass	Pass	$ -	$ -
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	Chico North and South Study Area, DWR NULE (URS, 2014)	Approx. 1,432 feet Fails to Meet Criteria	Approx. 1,432 feet Fails to Meet Criteria	$ 3,390,152	$ 4,746,212
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	Chico North and South Study Area, DWR NULE (URS, 2014)	Approx. 6,900 feet Fails to Meet Criteria	Approx. 6,900 feet Fails to Meet Criteria	$ 16,335,227	$ 22,869,318
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	Chico North and South Study Area, DWR NULE (URS, 2014)	Pass	Pass	$ -	$ -

Notes: *[1] – Assumes that costs to address any freeboard and/or geometry issues (Table 3A) are included in costs to address Seepage and/or Stability deficiencies.*
[2] - Lower bound cost estimate assumes a construction cost of $12.5M per mile of levee
[3] – Upper bound cost estimate assumes a construction cost of $17.5M per mile of levee

TABLE 4B – Estimated Cost to Repair Seepage/Stability Deficiencies Assuming All Levee Segments are Substandard[1]			
Levee Segment	**Length (miles)**	**Lower Bound Cost Estimate[2]**	**Upper Bound Cost Estimate[3]**
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	$ 43,750,000	$ 61,250,000
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	$ 22,375,000	$ 31,325,000
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	$ 18,750,000	$ 26,250,000
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	$ 41,250,000	$ 57,750,000
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	$ 52,500,000	$ 73,500,000
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	$ 36,250,000	$ 50,750,000
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	$ 23,125,000	$ 32,375,000
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	$ 18,750,000	$ 26,250,000
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	$ 36,250,000	$ 50,750,000
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	$ 18,750,000	$ 26,250,000

Notes: [1] *– Assumes that costs to address any freeboard and/or geometry issues (Table 3B) are included in costs to address Seepage and/or Stability deficiencies.*
[2] *- Lower bound cost estimate assumes a construction cost of $12.5M per mile of levee*
[3] *– Upper bound cost estimate assumes a construction cost of $17.5M per mile of levee*

TABLE 5 – Estimated Cost to Prepare As-Built Drawings and Revise Operation and Maintenance Manual		
Levee Segment	**Length (miles)**	**Estimated Cost[1]**
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	$ 135,000
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	$ 117,900
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	$ 115,000
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	$ 133,000
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	$ 142,000
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	$ 129,000
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	$ 118,500
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	$ 115,000
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	$ 129,000
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	$ 115,000

Notes: [1] – Assumes a base cost of $100k plus an additional 10% per mile of levee

TABLE 6 – Estimated Cost to Prepare the Engineers Summary Report for FEMA/ULOP Accreditation			
Levee Segment	**Length (miles)**	**FEMA Costs[1]**	**ULOP Costs[2]**
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	$ 70,000	$ 175,000
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	$ 35,800	$ 89,500
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	$ 30,000	$ 75,000
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	$ 66,000	$ 165,000
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	$ 84,000	$ 210,000
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	$ 58,000	$ 145,000
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	$ 37,000	$ 92,500
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	$ 30,000	$ 75,000
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	$ 58,000	$ 145,000
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	$ 30,000	$ 75,000

Notes: [1] *– FEMA cost estimate assumes $20k per mile of levee*
[2] *– ULOP cost estimate assumes $50k per mile of levee*

TABLE 7 – Total Estimated Costs for Accreditation

Levee Segment	Length (miles)	Total Estimated Costs for Accreditation					
		Assumes Freeboard Repairs Only Based on Current FEMA Evaluations[1]	Assumes Freeboard Repairs Only Based on Current ULOP Evaluations[2]	Investigation, Analysis and Repair of Freeboard and Other Deficiencies Assuming Findings of Existing Studies are Accurate - Lowerbound[3]	Investigation, Analysis and Repair of Freeboard and Other Deficiencies Assuming Findings of Existing Studies are Accurate - Upperbound[4]	Investigation, Analysis and Repair of Freeboard and Other Deficiencies Assuming Findings of Existing Studies are Incorrect and All Levees Need Repair - Lowerbound[5]	Investigation, Analysis and Repair of Freeboard and Other Deficiencies Assuming Findings of Existing Studies are Incorrect and All Levees Need Repair - Upperbound[6]
RIGHT BANK OF MUD CREEK, LM 2 to LM 5.5 (NA 3 Unit 1)	3.5	$1,825,318	$2,811,044	$50,241,350	$67,741,350	$50,241,350	$67,741,350
RIGHT BANK OF MUD CREEK, LM 5.5 to LM 7.29 (NA 3 Unit 1)	1.79	$842,878	$1,022,561	$9,434,674	$12,275,583	$25,929,219	$34,879,219
LEFT BANK OF MUD CREEK, LM 0 to LM 1.5 (NA 3 Unit 2)	1.5	$411,452	$572,177	$21,829,150	$29,329,150	$21,829,150	$29,329,150
LEFT BANK OF MUD CREEK, LM 1.5 to LM 4.8 (NA 3 Unit 2)	3.3	$1,686,907	$2,487,065	$2,606,130	$2,606,130	$47,406,130	$63,906,130
RIGHT BANK OF SYCAMORE CREEK (Including Sheep Hollow Creek), LM 0 to LM 4.2 (NA 3 Unit 3)	4.2	$3,198,164	$5,161,792	$60,454,620	$81,454,620	$60,454,620	$81,454,620
LEFT BANK OF SYCAMORE CREEK, LM 0 to LM 2.9 (NA 3 Unit 4)	2.9	$540,942	$2,648,151	$2,255,690	$2,255,690	$41,655,690	$56,155,690
LEFT BANK OF SYCAMORE CREEK DIVERSION CHANNEL, LM 0 to LM 1.85 (NA 3 Unit 5)	1.85	$155,500	$211,000	$1,640,785	$1,640,785	$26,865,785	$36,115,785
LEFT BANK OF BUTTE CREEK, LM 0 to LM 1.5 (MA 5 Unit 1)	1.5	$2,565,967	$3,089,002	$5,100,514	$6,456,574	$21,689,150	$29,189,150
RIGHT BANK OF BUTTE CREEK, LM 13.6 to LM 16.5 (MA 5 Unit 2)	2.9	$3,197,705	$3,743,548	$20,067,735	$26,601,826	$41,575,690	$56,075,690
RIGHT BANK OF LITTLE CHICO DIVERSION CHANNEL, LM 0 to LM 1.5 (MA 5 Unit 3)	1.5	$1,124,446	$2,339,998	$1,369,150	$1,369,150	$21,869,150	$29,369,150
TOTAL		$15,549,280	$24,086,338	$174,999,798	$231,730,858	$359,515,934	$484,215,934

Notes: [1] – *Assumes repair of 100-year freeboard deficiencies only without any additional investigation or analysis (Table 3A, Table 5 and Table 6)*

[2] – *Assumes repair of 200-year freeboard deficiencies only without any additional investigation or analysis (Table 3B, Table 5 and Table 6)*

[3] - *Assumes conclusions of existing reports regarding substandard sections of levee are still accurate based on geotechnical information collected and analysis performed as part of ongoing accreditation process. Design and repair costs for existing substandard section of levee only (Table 1, Table 2A, Table 4A (Lowerbound Estimate), Table 5 and Table 6 (FEMA and ULOP Costs))*

[4] - *Assumes conclusions of existing reports regarding substandard sections of levee are still accurate based on geotechnical information collected and analysis performed as part of ongoing accreditation process. Design and repair costs for existing substandard section of levee only (Table 1, Table 2A, Table 4A (Upperbound Estimate), Table 5 and Table 6 (FEMA and ULOP Costs))*

[5] - *Assumes all levees are substandard based on geotechnical information collected and analysis performed as part of ongoing accreditation process. Design and repair costs for all levees (Table 1, Table 2B, Table 4B (Lowerbound Estimate), Table 5 and Table 6 (FEMA and ULOP Costs))*

[6] - *Assumes all levees are substandard based on geotechnical information collected and analysis performed as part of ongoing accreditation process. Design and repair costs for all levees (Table 1, Table 2B, Table 4B (Upperbound Estimate), Table 5 and Table 6 (FEMA and ULOP Costs))*

FIGURES

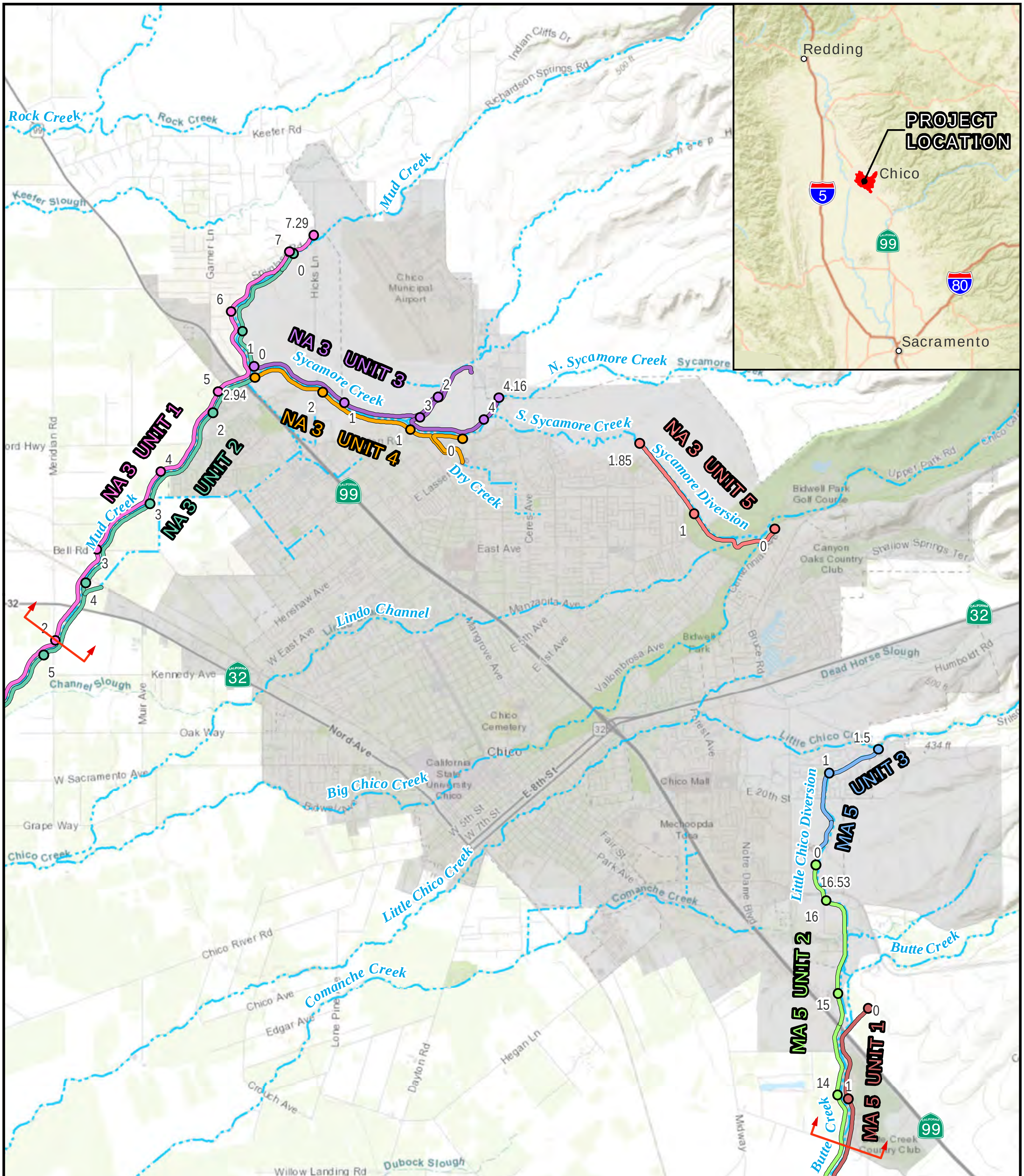


FIGURE 1

LEVEE SYSTEM LOCATION MAP

STORM WATER MASTER PLAN

CITY OF CHICO

BUTTE COUNTY, CALIFORNIA

APRIL 2024

NORTH

0 0.625 1.25 2.5

Miles

10 Levee and Mile Marker

Streams

Chico SOI

Project Extents

WOOD RODGERS

\\woodrodgers.loc\ProductionData\Jobs\Jobs\8835_City_of_Chico\8835001_Chico_SWMP\GIS\Tasks\Levee_Figures\FIG-01_LocationMap_20240424.mxd 4/24/2024 4:50:00 PM jpriest

PHASES	WORK ACTIVITY
1A	**IDENTIFY DATA GAPS** Review existing geotechnical information in relation to required coverage based on USACE Standard Operating Procedures 3 (USACE, 2022), and identify the need for additional information.
1B	**OBTAIN AN APPROVED DRILLING AND INVASIVE PROGRAM PLAN** In accordance with USACE ER 1110-1-1807, Drilling and Invasive Activities at Dam and Levees, an approved Drilling and Invasive Program Plan is required prior to any drilling or invasive activities located in/on/under all USACE dams or levees, or if owned and operated by non-federal sponsors.
2	**SUBSURFACE INVESTIGATION AND GEOTECHNICAL DATA REPORT** Obtain supplemental geotechnical information necessary to meet USACE SOP 3 standards and enable existing conditions geotechnical analysis to be completed to assess compliance with industry standards. A Geotechnical Data Report will be prepared presenting the findings of the investigation.
3	**GEOTECHNICAL EVALUATION AND RECOMMENDATIONS REPORT** Conduct existing conditions geotechnical analysis (erosion, embankment and foundation stability, and settlement) and/or perform new analysis to identify the condition of the levee system with regard to current industry standards. Additional evaluations, such as seismic, may be required depending on the site setting and type of accreditation being sought. For levee reaches that do not meet criteria, additional remedial alternatives analysis will be required to identify measures needed to bring deficient reaches into compliance. A Geotechnical Evaluation Recommendation Report will be prepared presenting the findings of the study.
4A	**CONSTRUCTION BID PACKAGE** Preparation of final plans, specifications, and construction cost estimates for the design of flood risk reduction measures necessary to bring substandard sections of levee up to standard.
4B	**PERMITTING** Environmental support for permitting of the project, including CEQA, NEPA, USACE 404 and 408, and other technical studies.
4C	**CONSTRUCTION** Once the construction bid package has been finalized and all permits are in hand, the project can be bid for construction. The construction window for work within existing floodways, including existing levees, is constrained by the flood season as identified by the CVFPB and typically spans from mid-April to mid-October.
5	**PREPARE AS-BUILTS DRAWINGS AND AN UPDATED OPERATION AND MAINTENANCE MANUAL** Following construction of levee upgrading works to achieve full compliance, As-built records of the completed works and an updated Operation and Maintenance Manual will need to be prepared.
6	**PREPARE AN ENGINEERS REPORT PROVIDING CERTIFICATION OF COMPLIANCE** Following completion of the above steps an agency will be in a position to compile an Engineer's Summary Report presenting proof of compliance with required standards.

FIGURE 2

LEVEE ACCREDITATION PROCESS SYSTEM
WORK FLOW CHART

STORM WATER MASTER PLAN
CITY OF CHICO
BUTTE COUNTY, CALIFORNIA
APRIL 2024

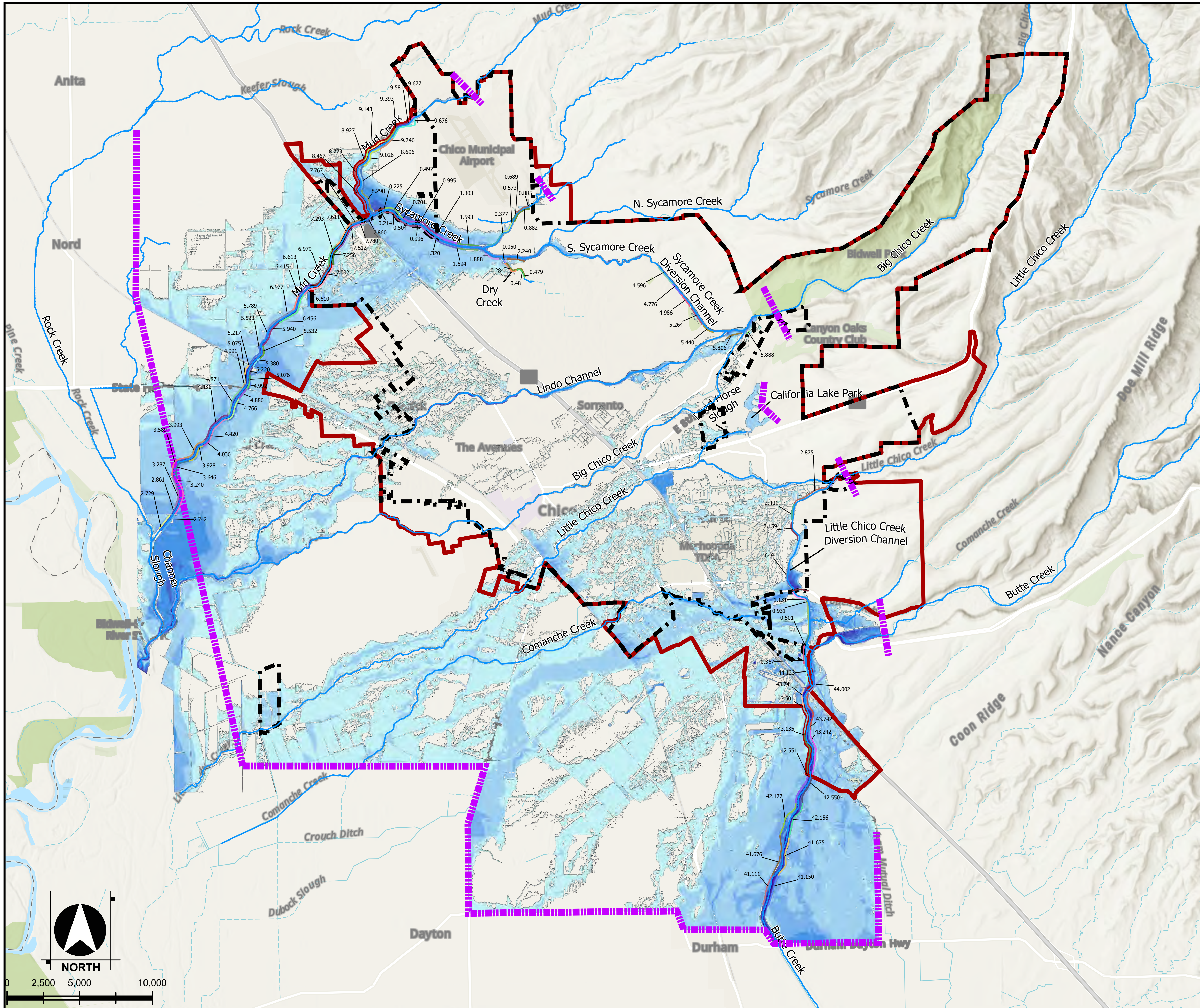
WOOD RODGERS

FIGURE 3

100-YEAR FLOODPLAIN BASED ON LEVEE DE-ACCREDITATION

CITY OF CHICO

MAY 2024



Legend

- Streams
- Study Limits
- City Limits
- Sphere of Influence

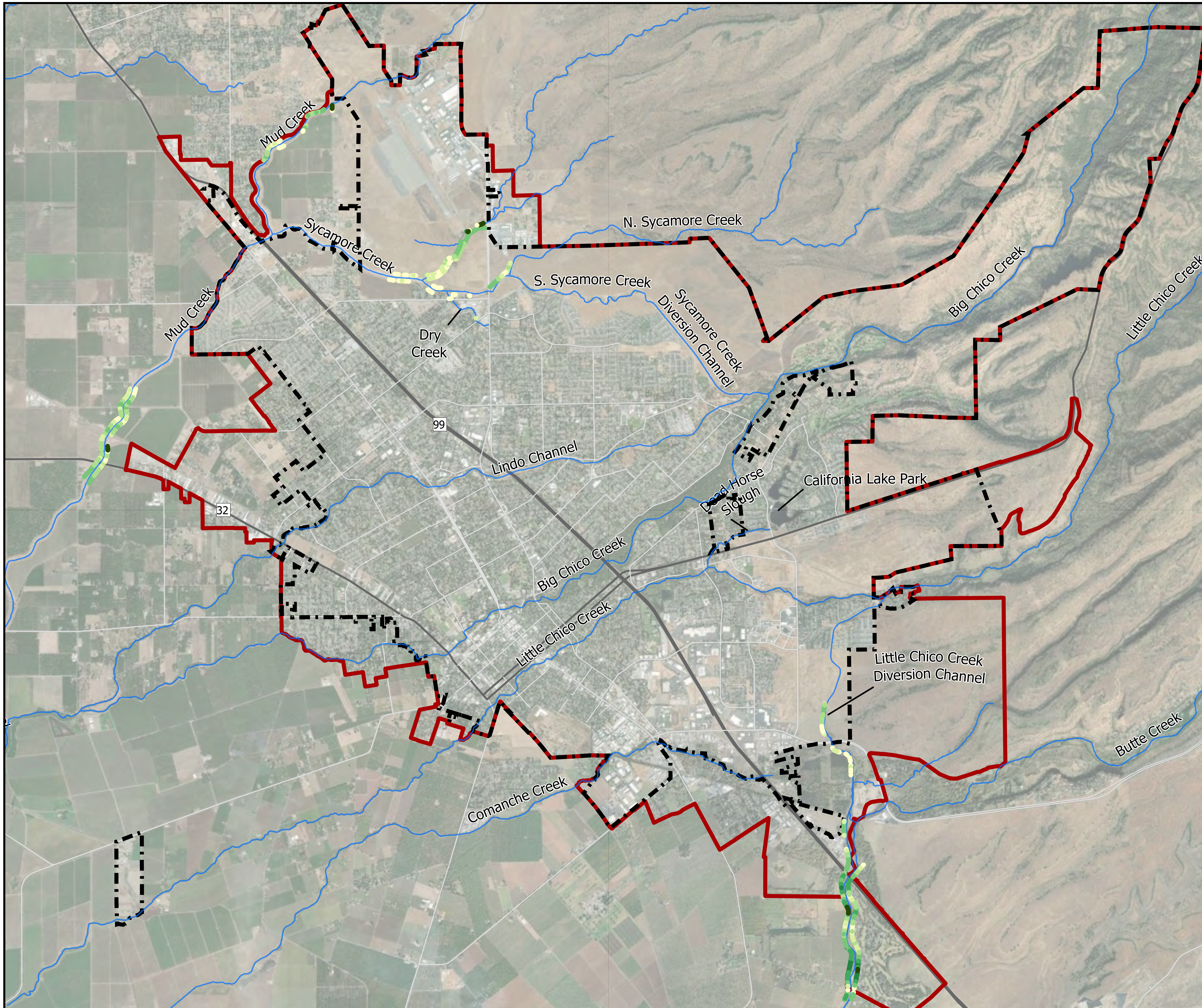
100-Year Inundation Area

Value

- 0 - 1 foot
- 1 foot - 3 feet
- 3 feet - 5 feet
- 5 feet - 8 feet
- 8 feet - 11 feet
- 11 feet - 15 feet
- Greater Than 15 feet

WOOD RODGERS

J:\Jobs\8835_City_of_Chico\8835001_Chico_SWMP\GIS\ArcGISPro\8835001_Chico_SWMP_Floodplain_KW\8835001_Chico_SWMP_Floodplain_KW.aprx 5/29/2024 5:19 PM kbarragan



100-YEAR FREEBOARD DEFICIENCY

STORM WATER MASTER PLAN

CITY OF CHICO

MAY 2024

Legend

- Streams
- Sphere of Influence
- City Limits

Freeboard Deficiency

- < 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- > 3.0

NOTE:
1. Levee freeboard was not evaluated for the levees downstream from California Park Lake.

WOOD RODGERS

J:\Jobs\8835_City_of_Chico\8835001_Chico_SWMP\GIS\ArcGISPro\Freeboard_Deficiencies\Freeboard_Deficiencies_20240531\Freeboard_Deficiencies_20240531.aprx 5/31/2024 11:19 AM Mcedeno

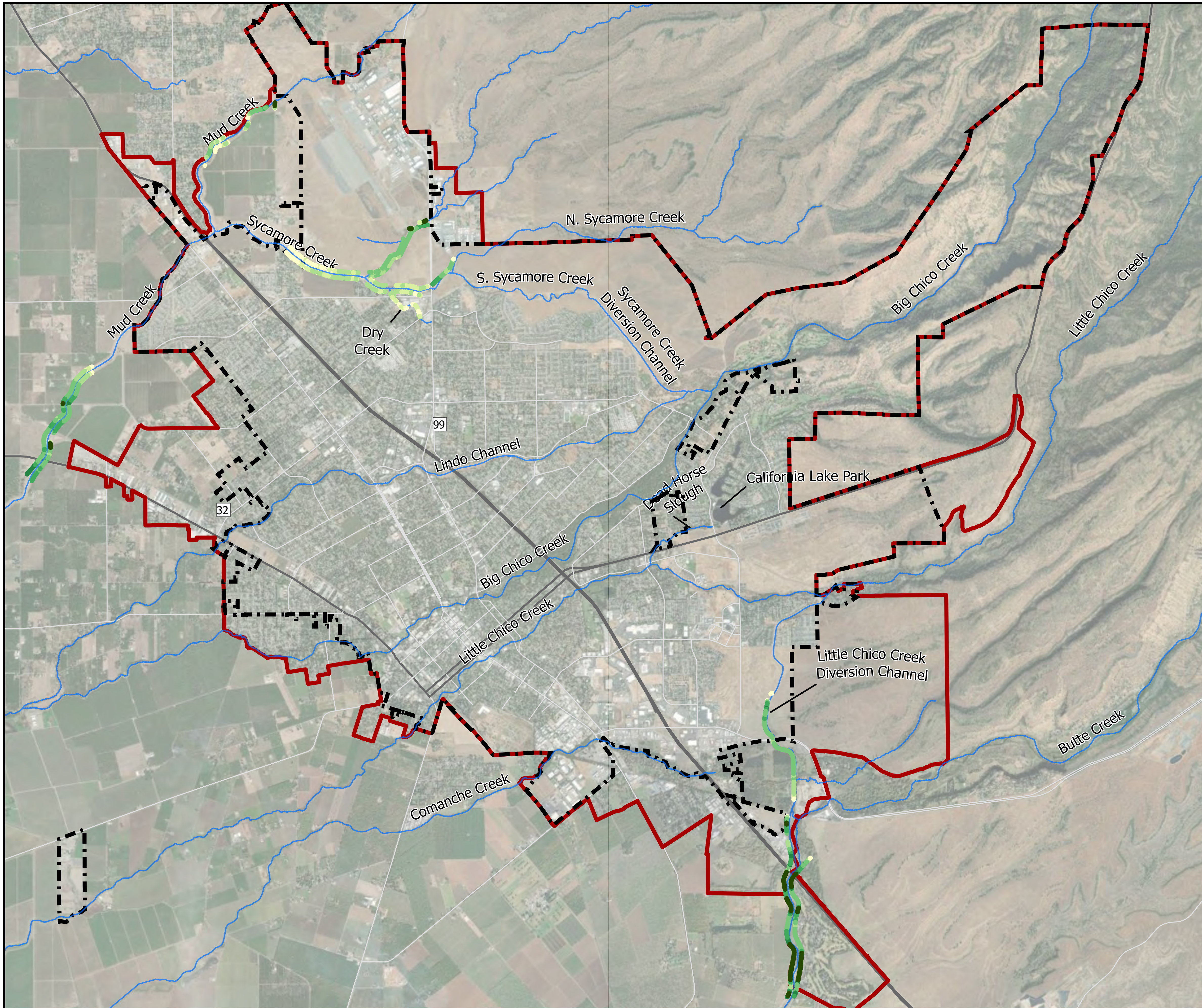
FIGURE 4

200-YEAR FREEBOARD DEFICIENCY

STORM WATER MASTER PLAN

CITY OF CHICO

MAY 2024



Legend

- Streams
- City Limits
- Sphere of Influence

Freeboard Deficiency

- < 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- > 3.0

NOTE:
1. Levee freeboard was not evaluated for the levees downstream from California Park Lake.

WOOD RODGERS

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FIGURE 5

City of Chico

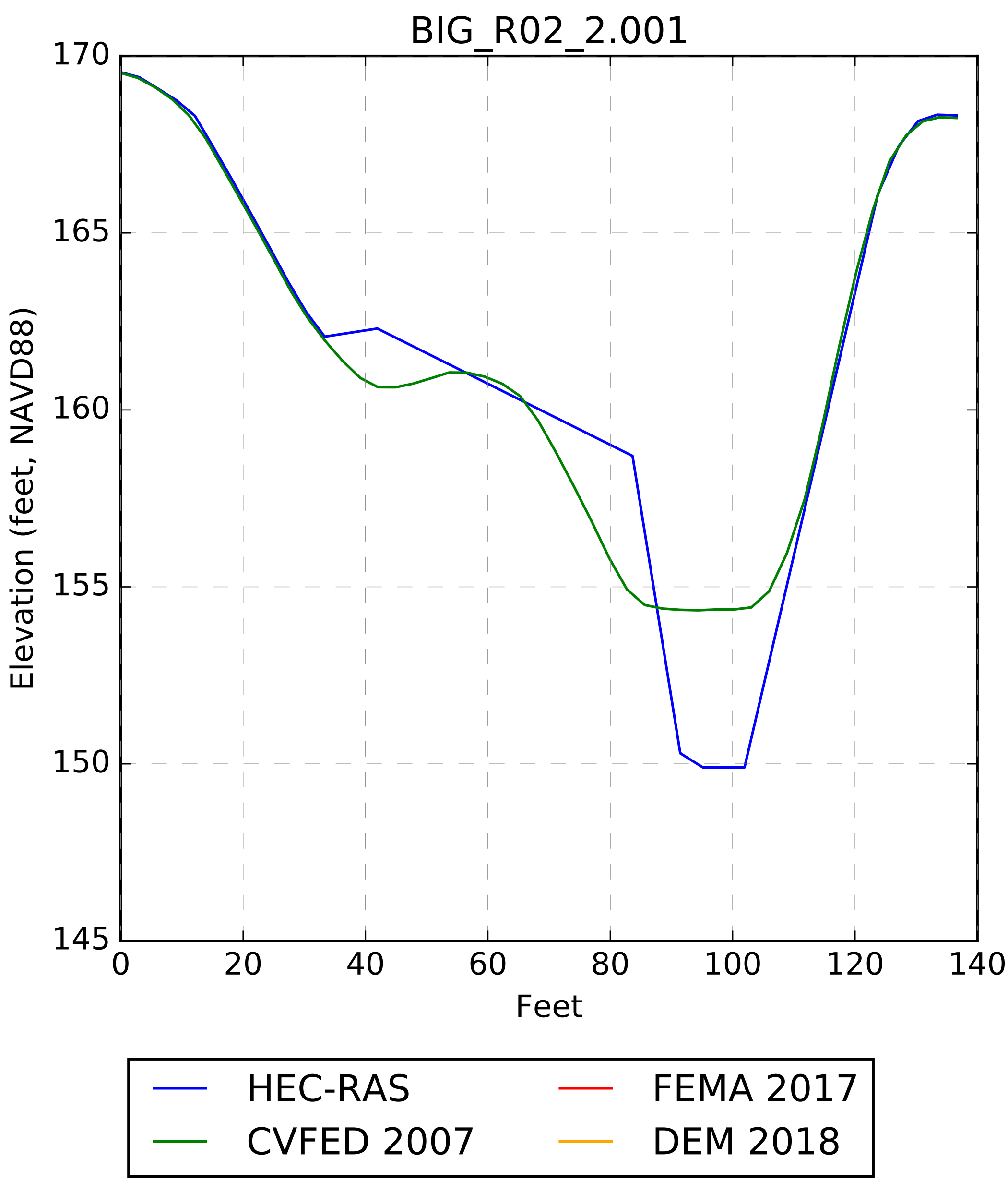
Storm Water Master Plan

Appendix F – Cross Section Survey and Modification Recommendations

City of Chico

Storm Water Master Plan

Appendix F.1 – Big Chico Creek Cross Section Comparisons



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Feet
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160
155
150
145
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20
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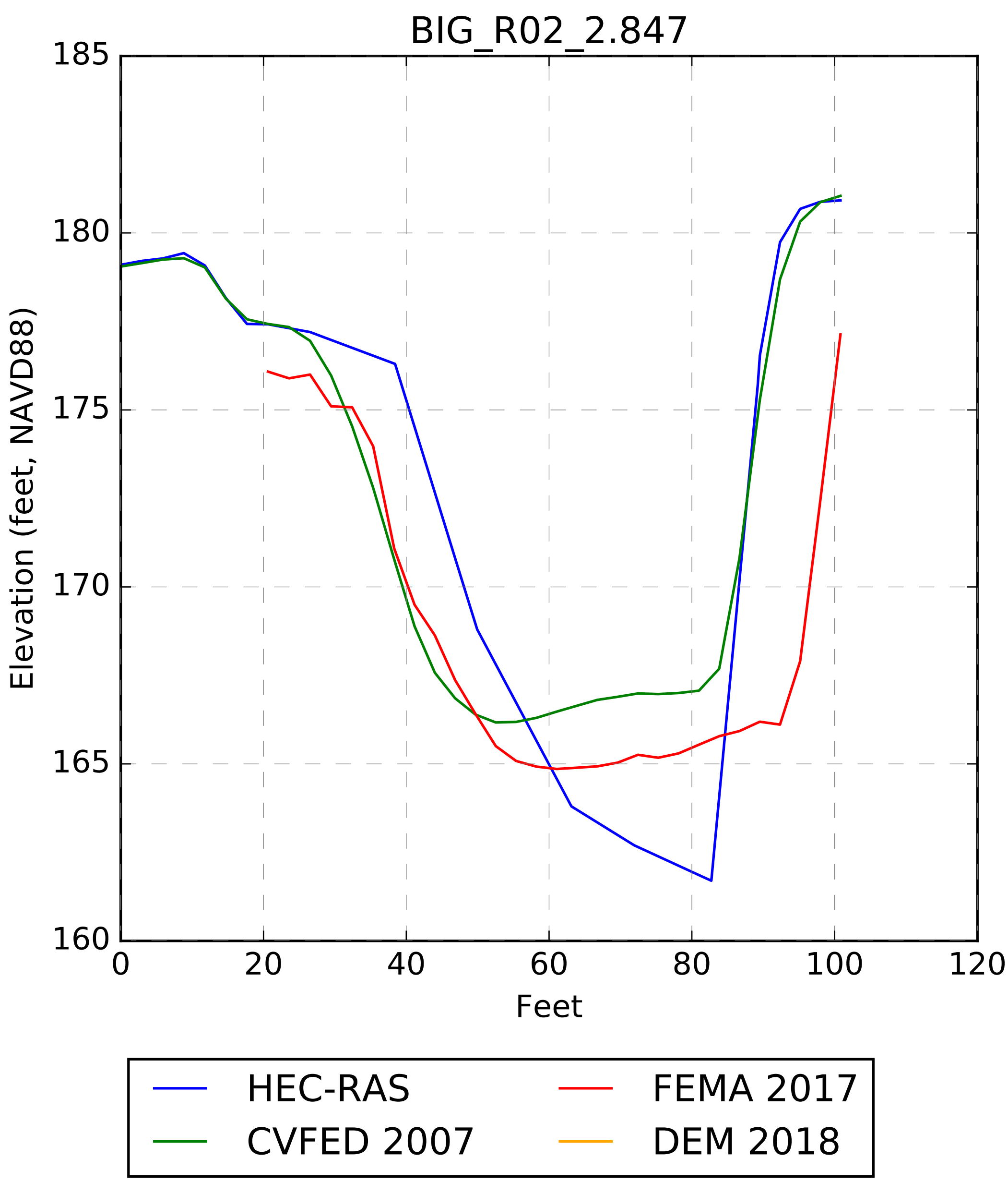
60
80
100
120
140
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018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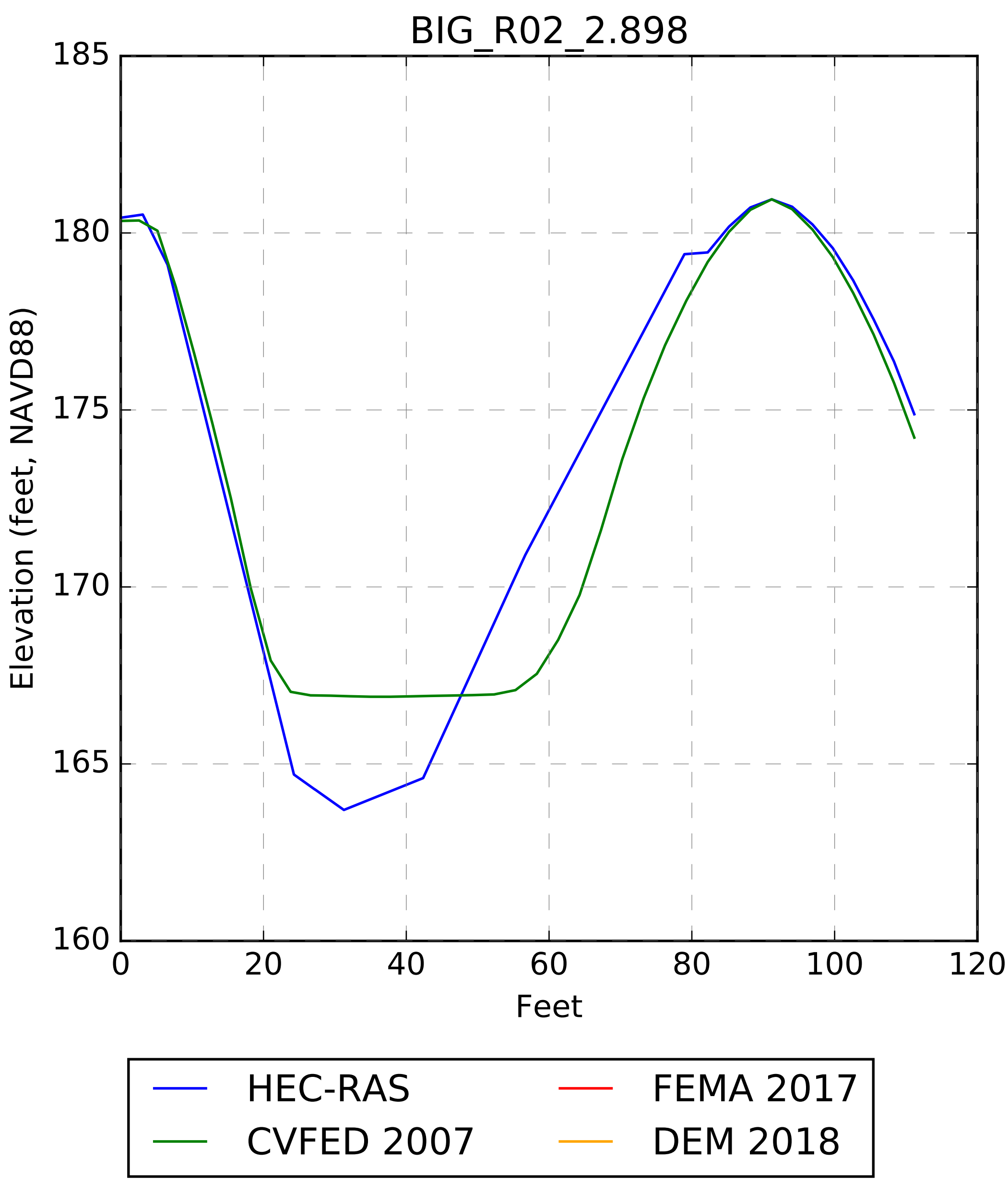
CVFED 2007
FEMA 2017
DEM 2018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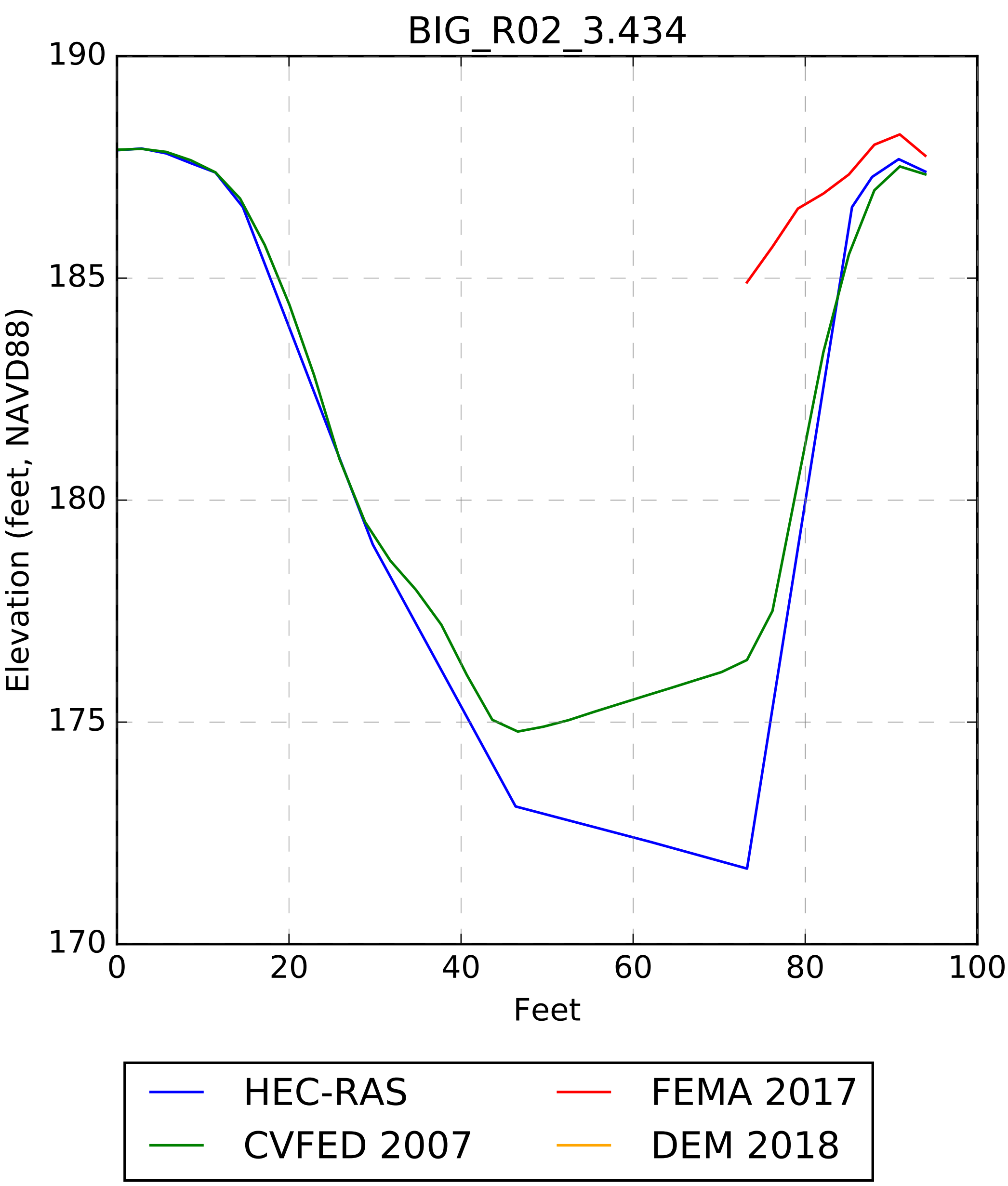
CVFED 2007
FEMA 2017
DEM 2018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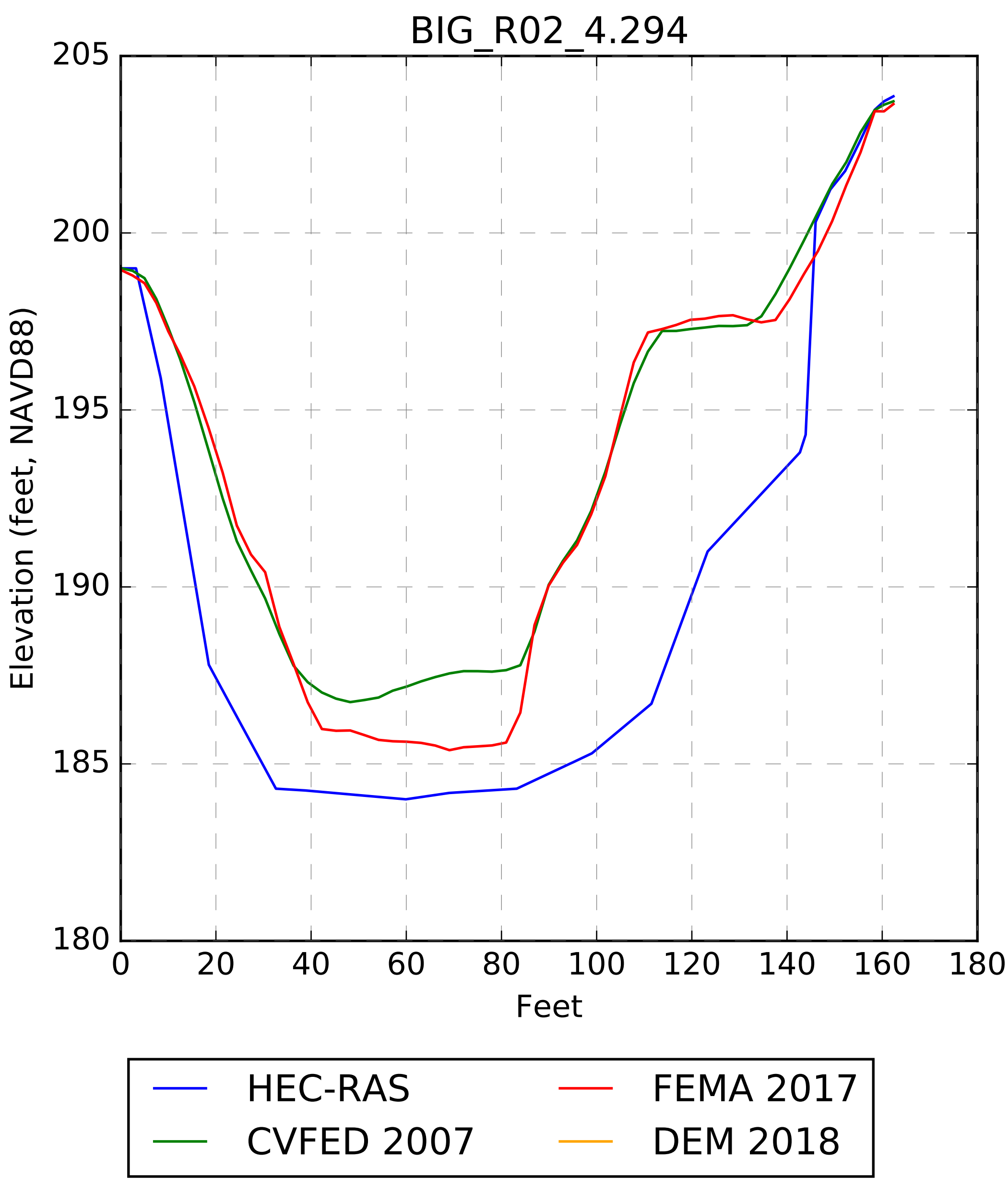
DEM 2018



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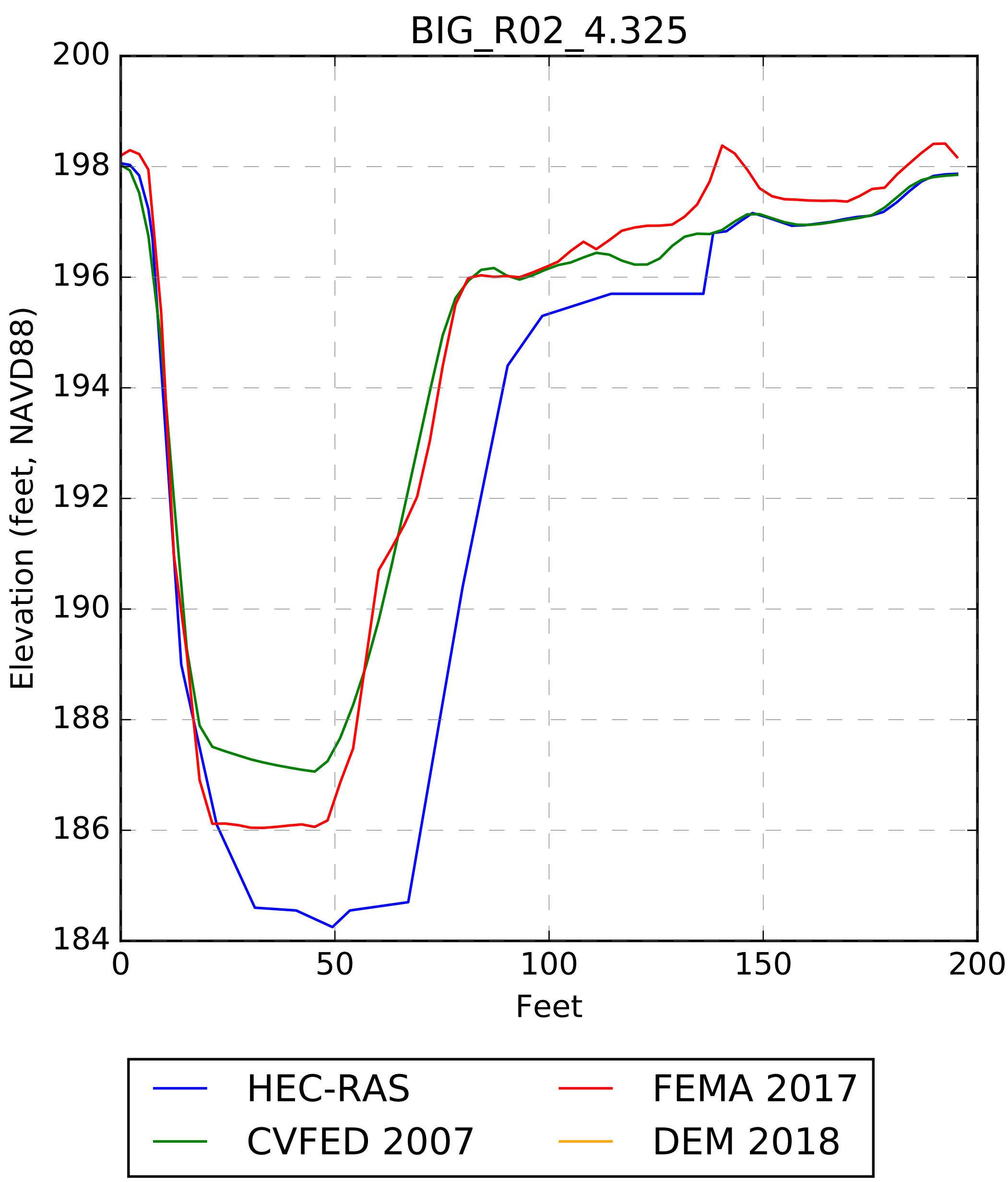
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



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194
192
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Elevation (feet, NAVD88)
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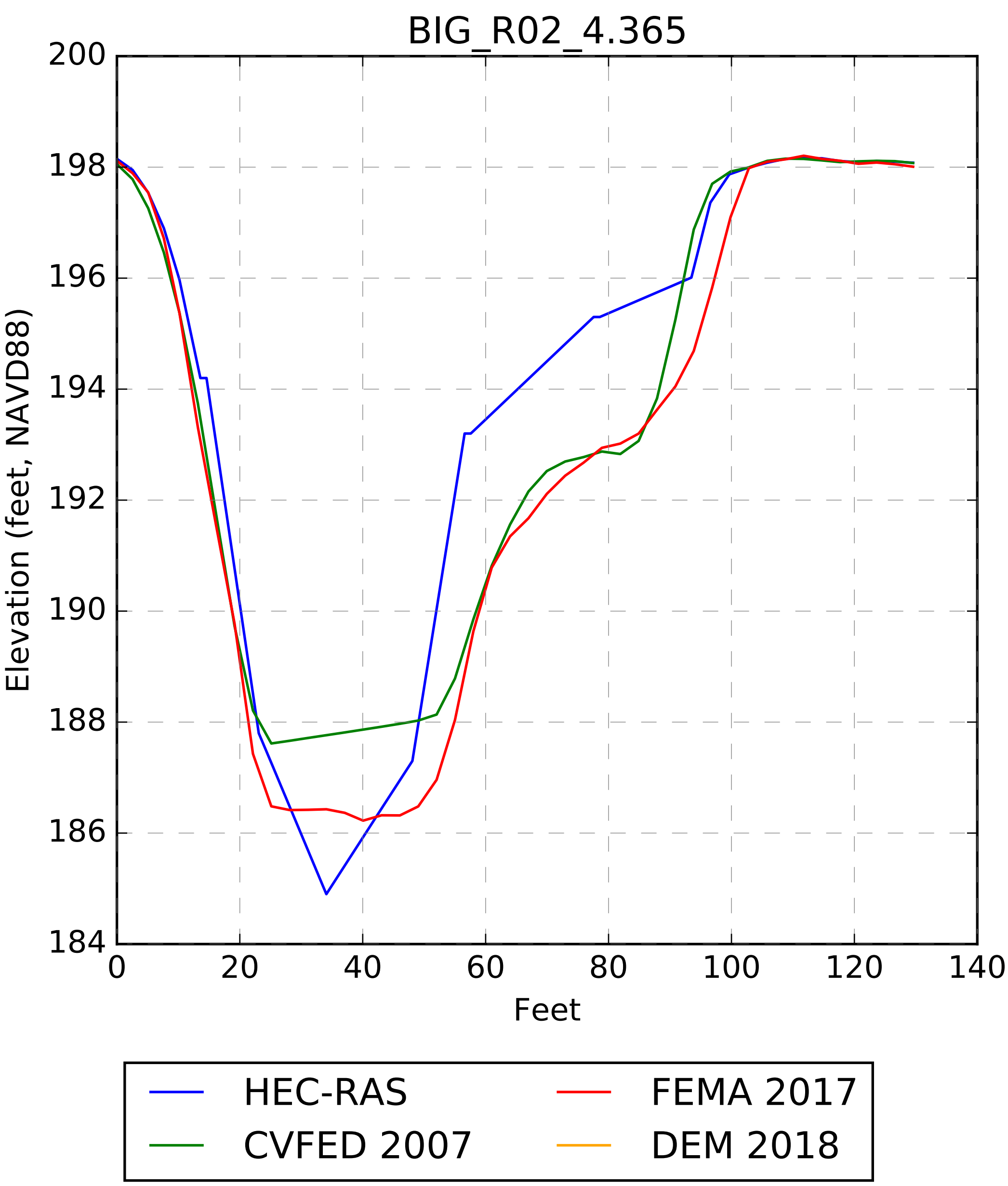
Feet
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018



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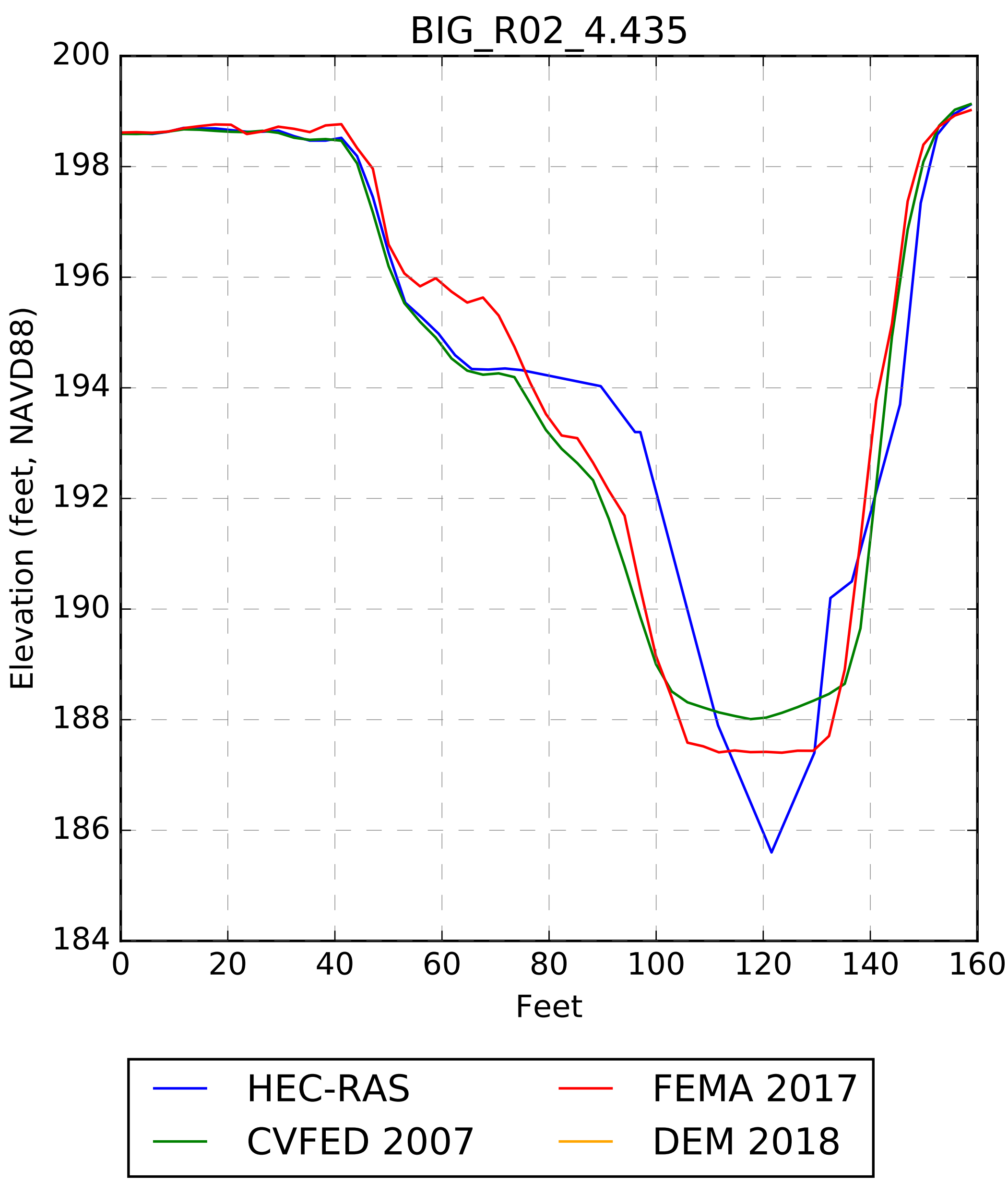
Feet
Elevation (feet, NAVD88)
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



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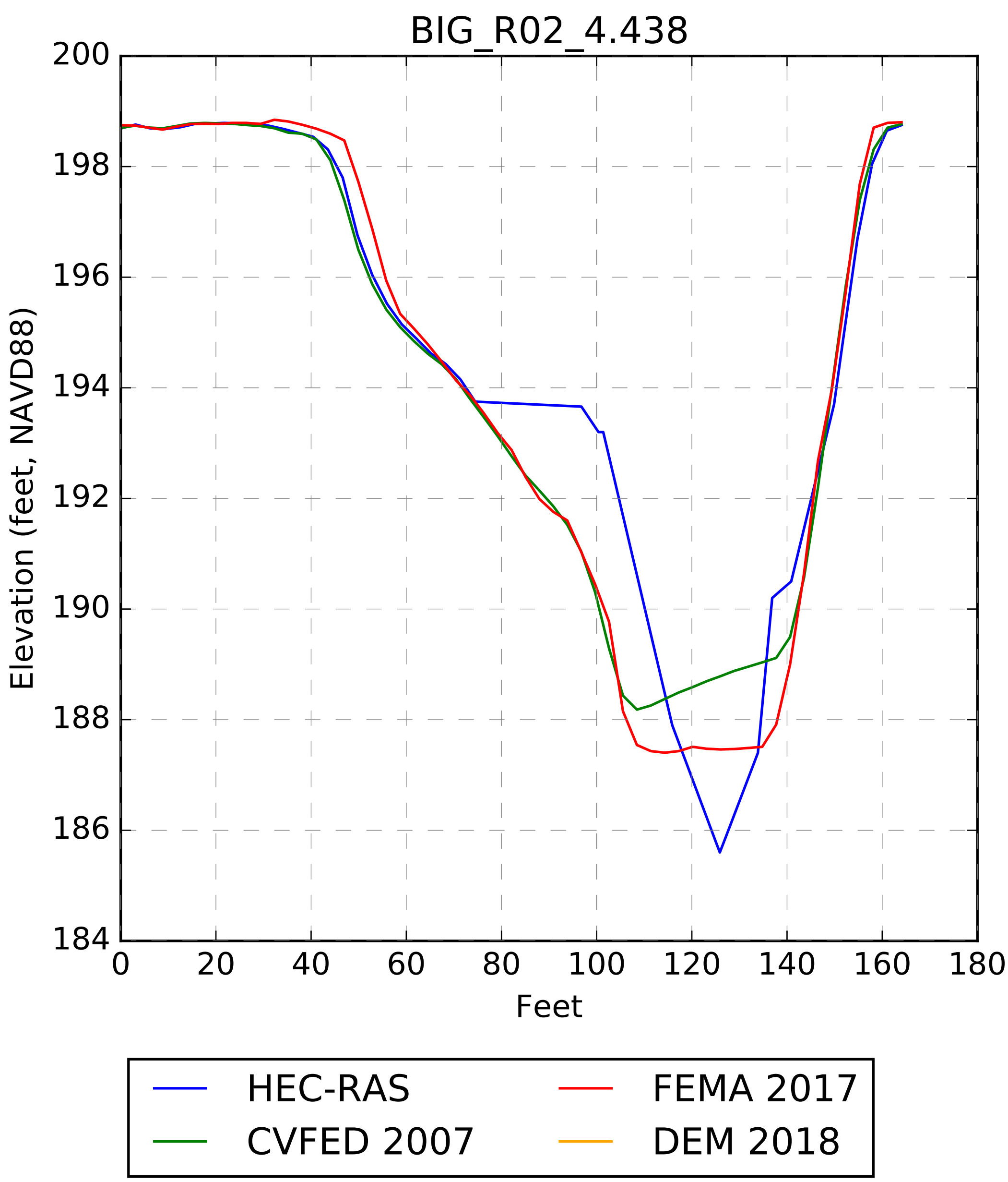
FEMA 2017
CVFED 2007
DEM 2018



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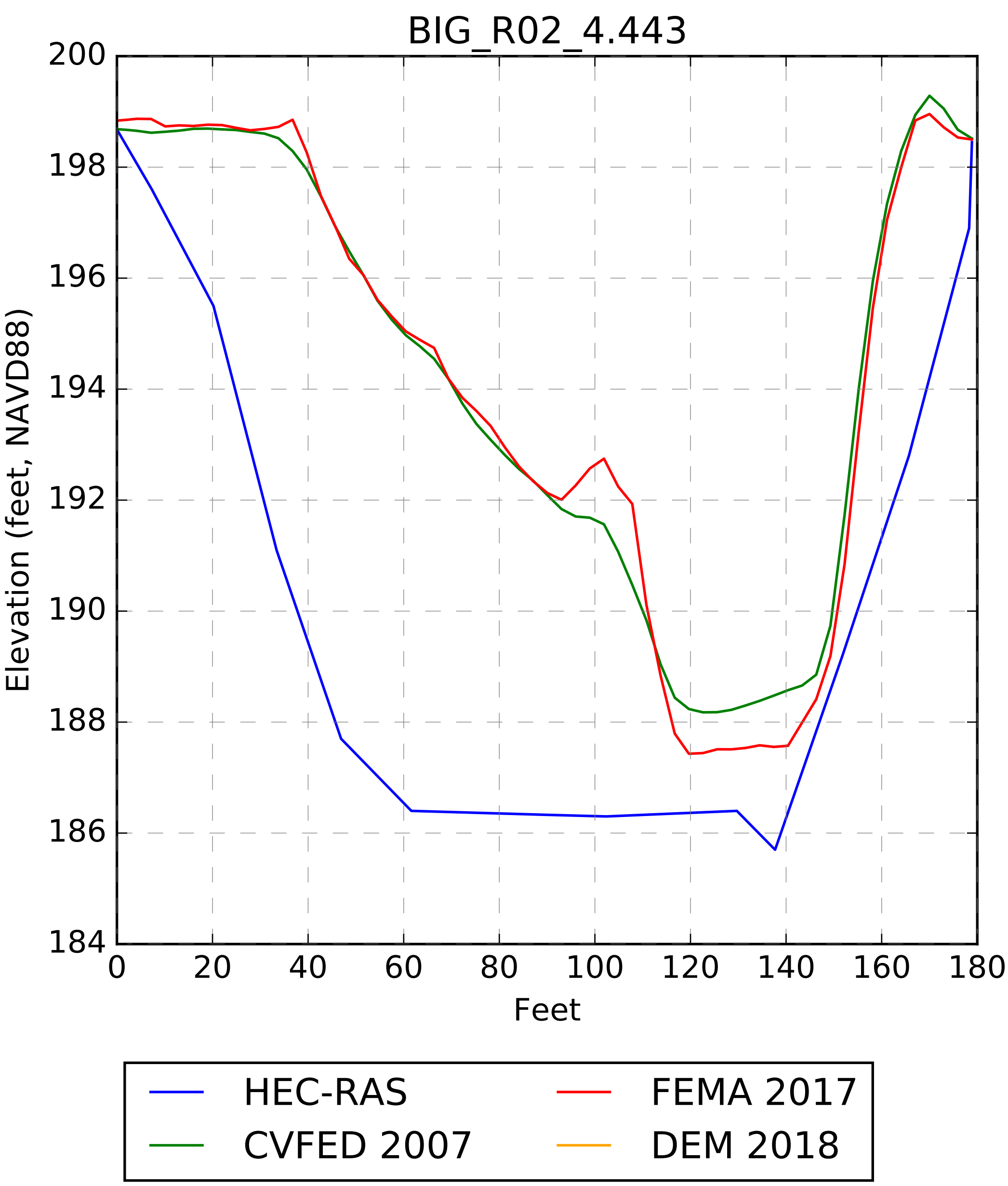
FEMA 2017
CVFED 2007
DEM 2018



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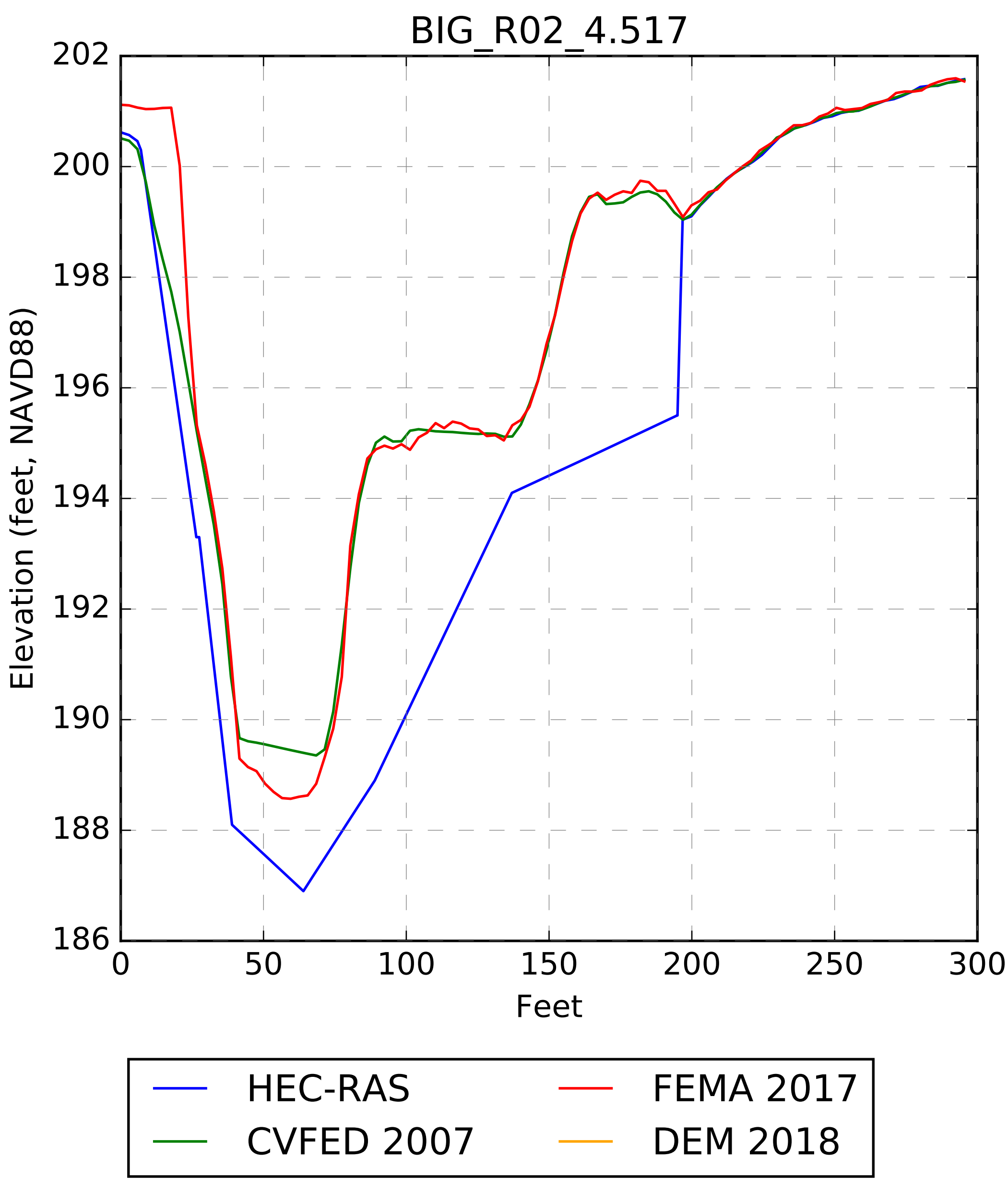
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018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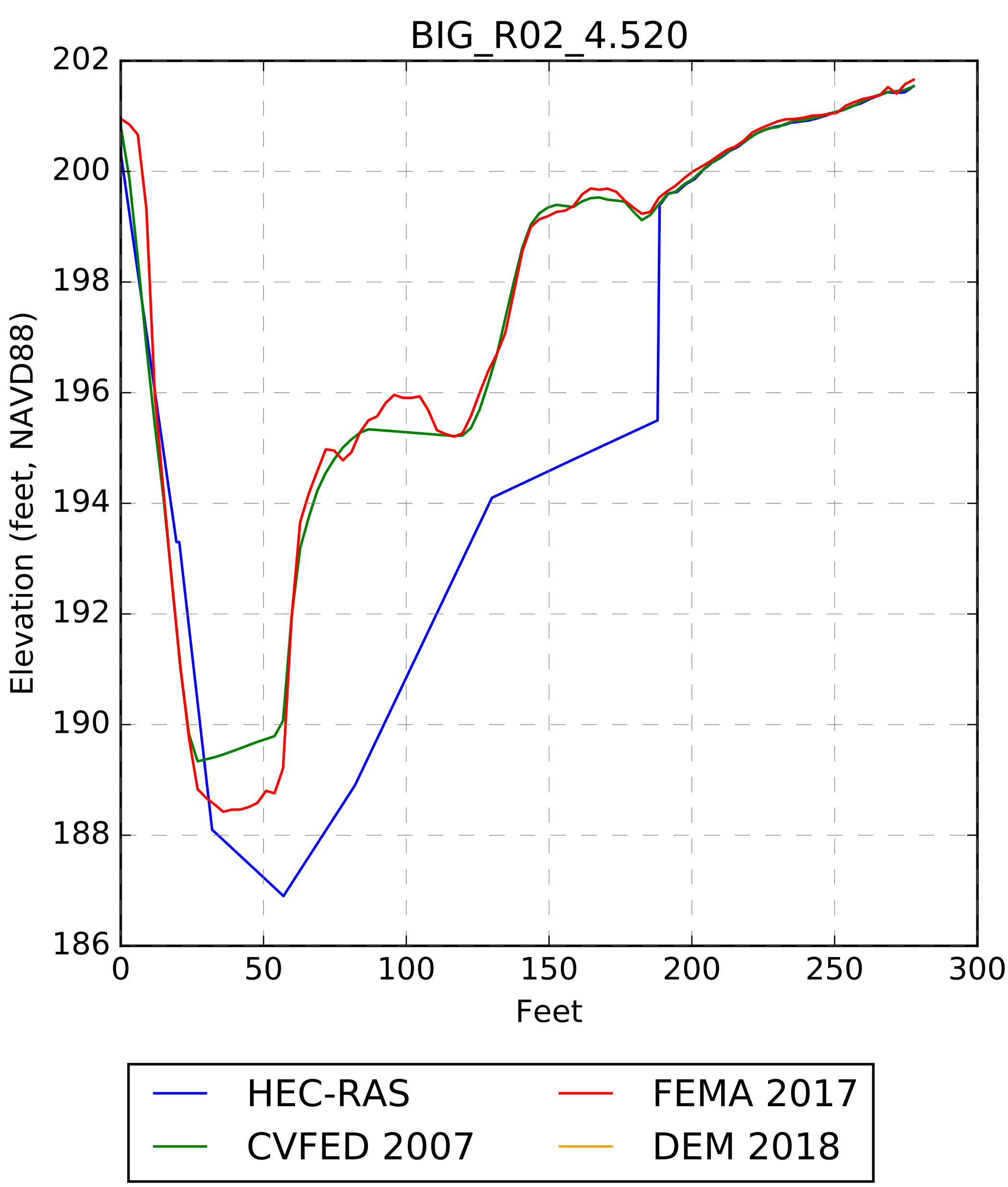
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018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CVFED 2007
FEMA 2017
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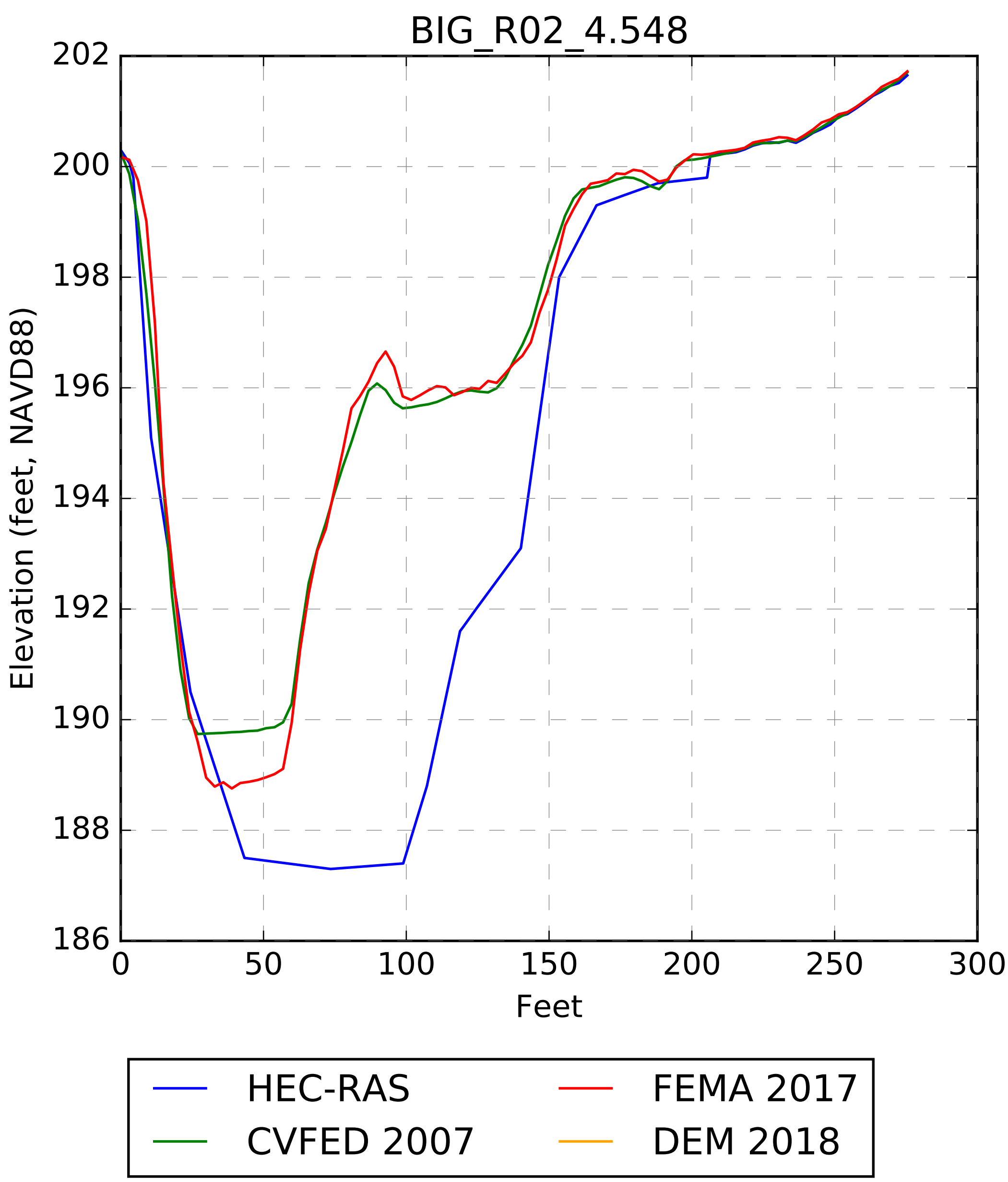
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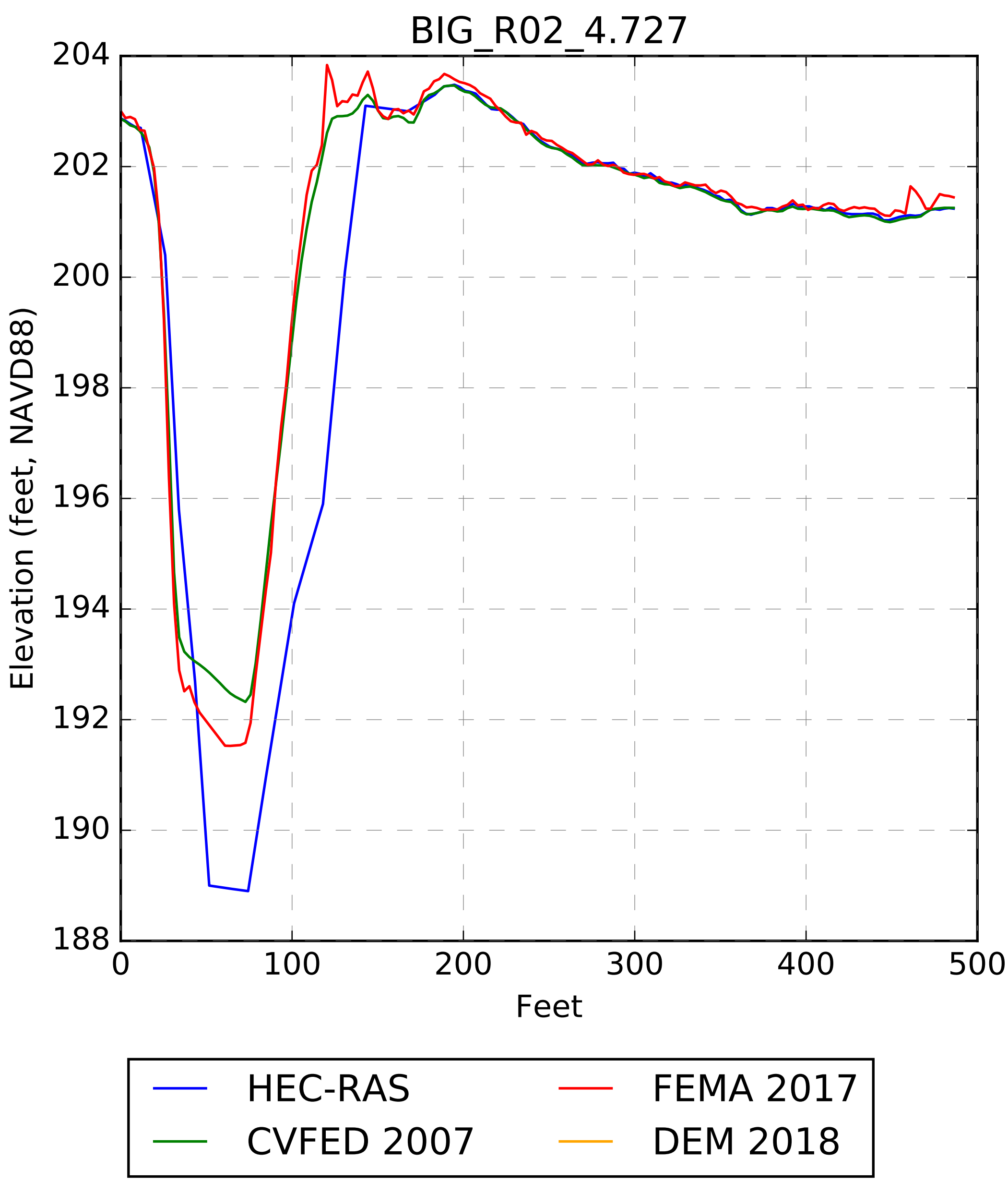
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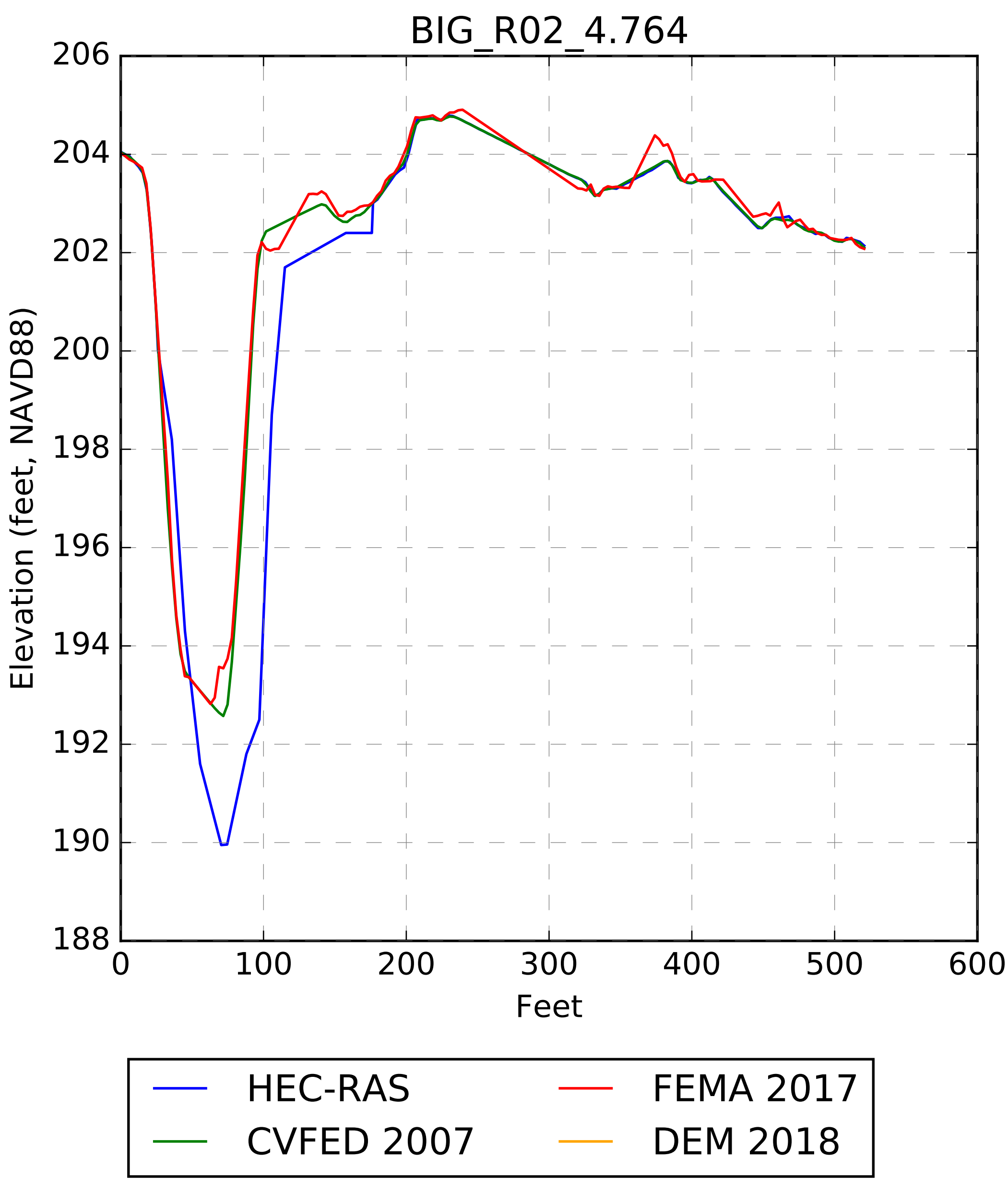
CVFED 2007
FEMA 2017
DEM 2018



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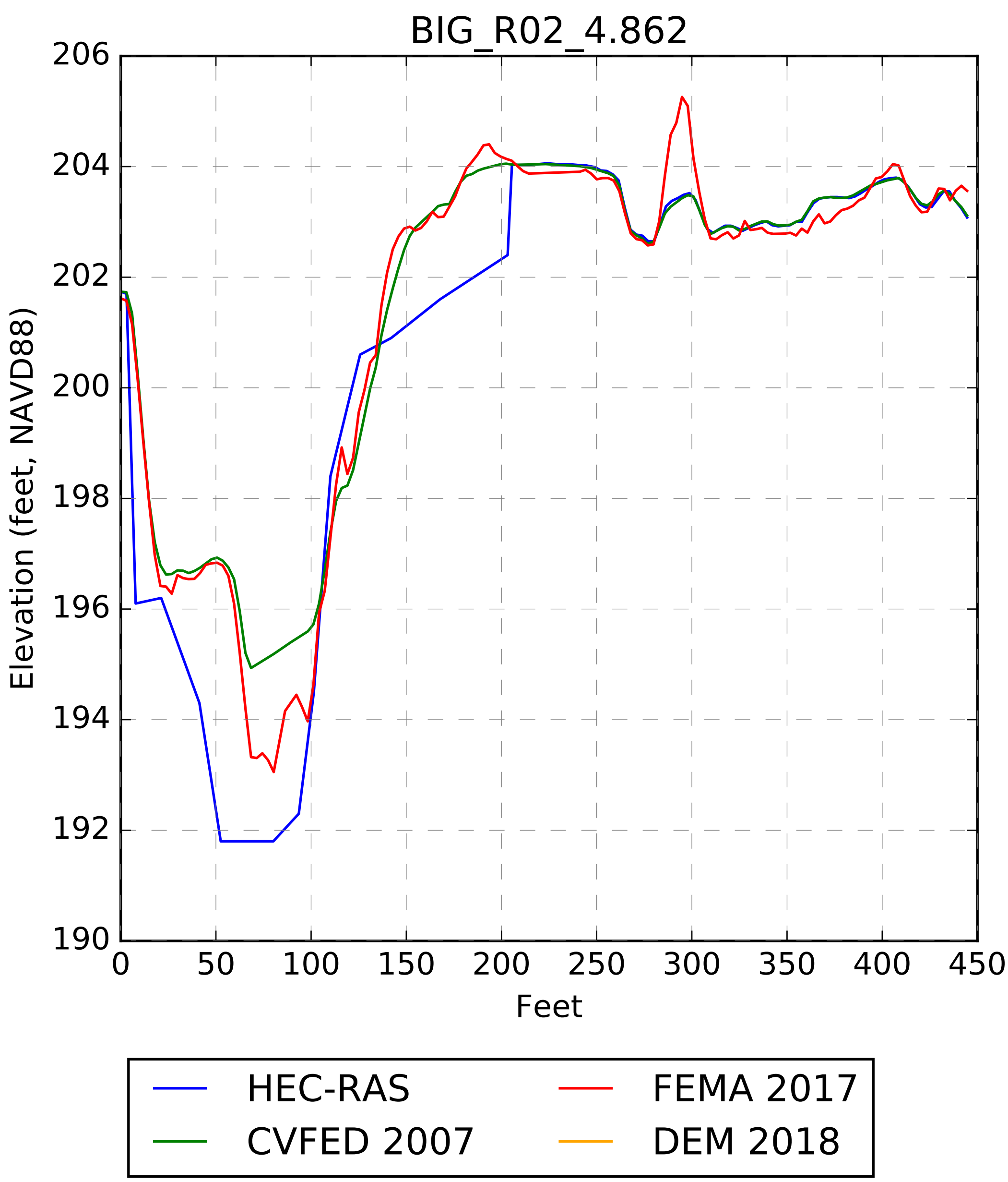
CVFED 2007
FEMA 2017
DEM 2018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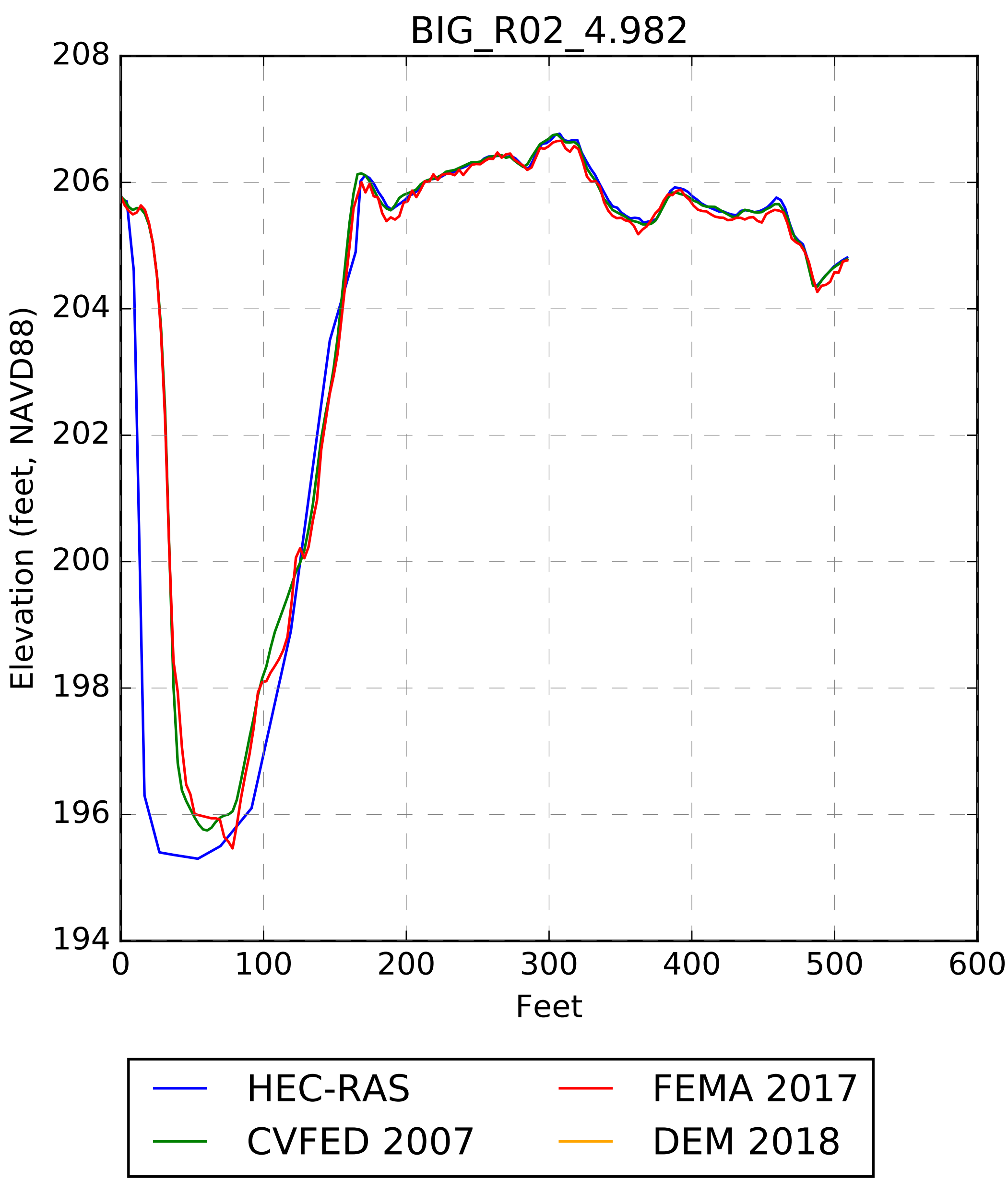
FEMA 2017
CVFED 2007
DEM 2018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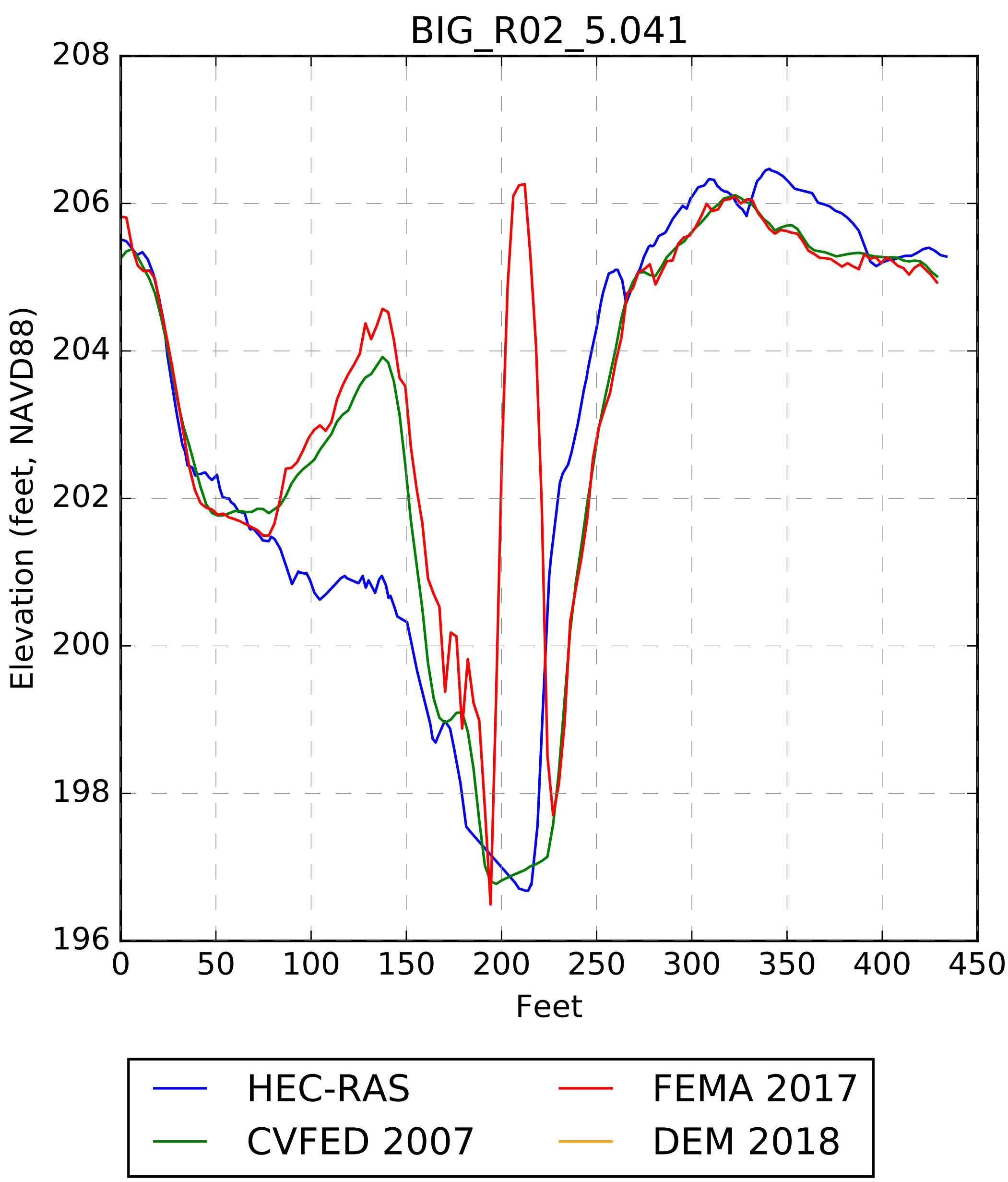
CVFED 2007
FEMA 2017
DEM 2018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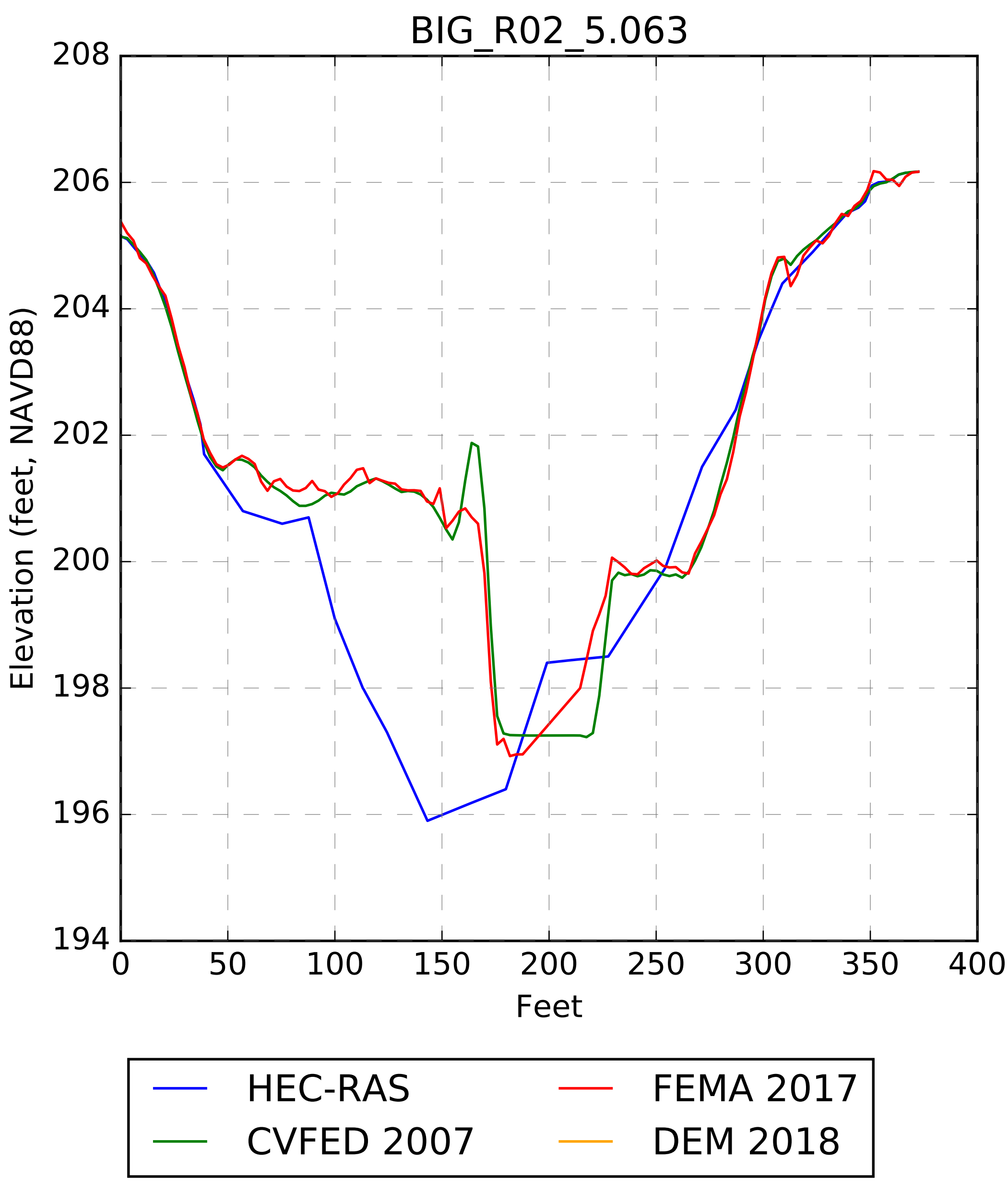
CVFED 2007
FEMA 2017
DEM 2018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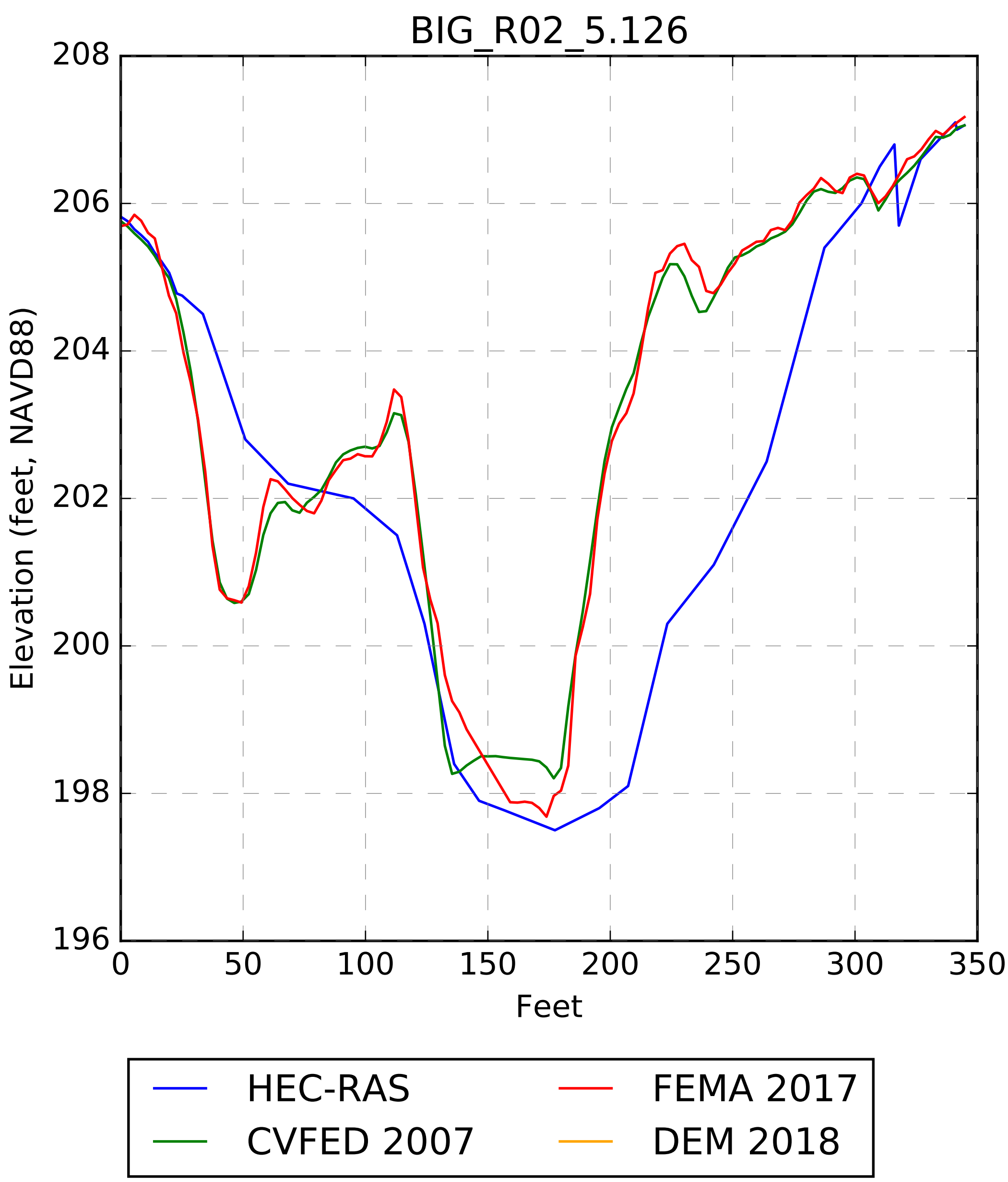
FEMA 2017
DEM 2018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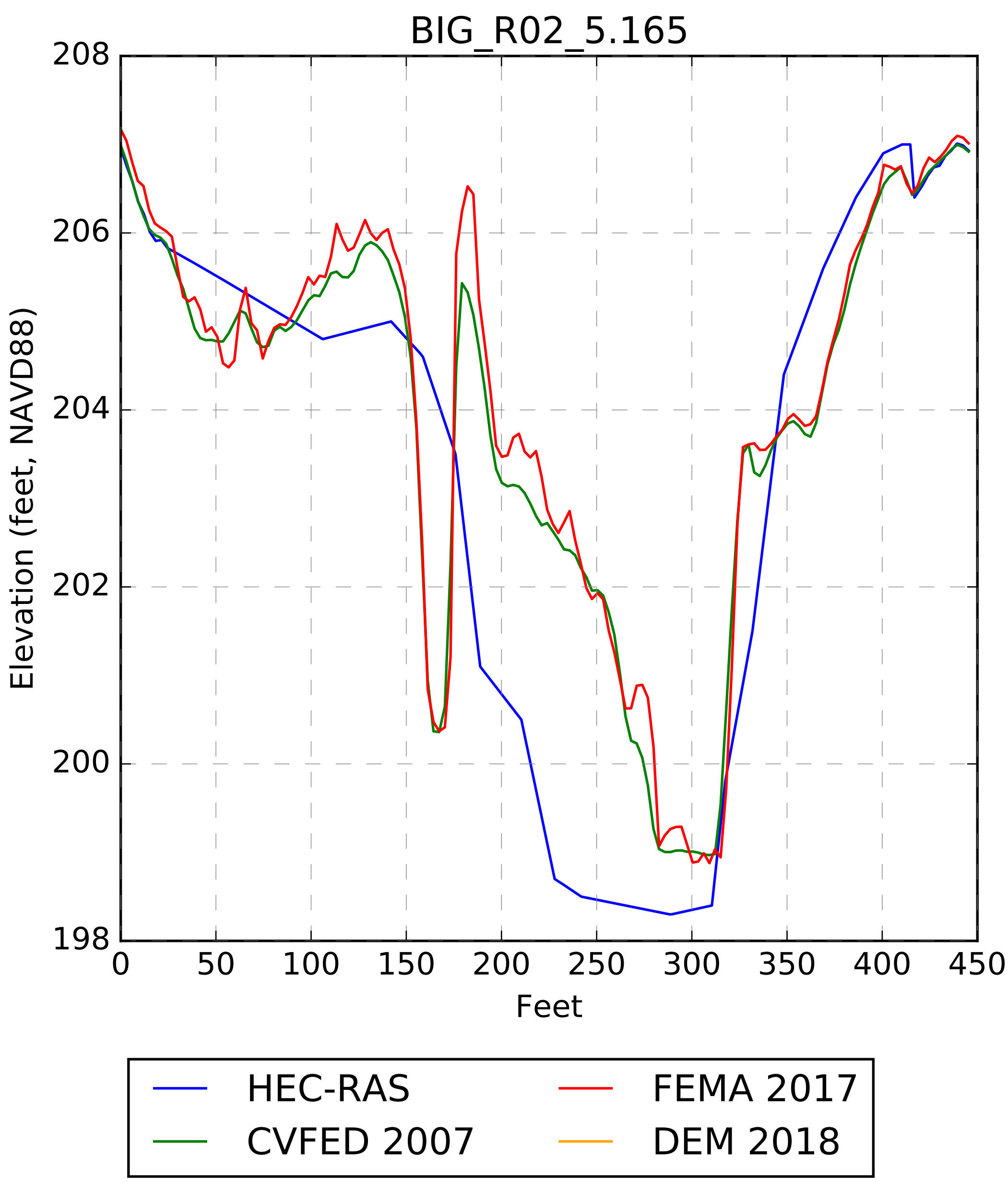
CVFED 2007
FEMA 2017
DEM 2018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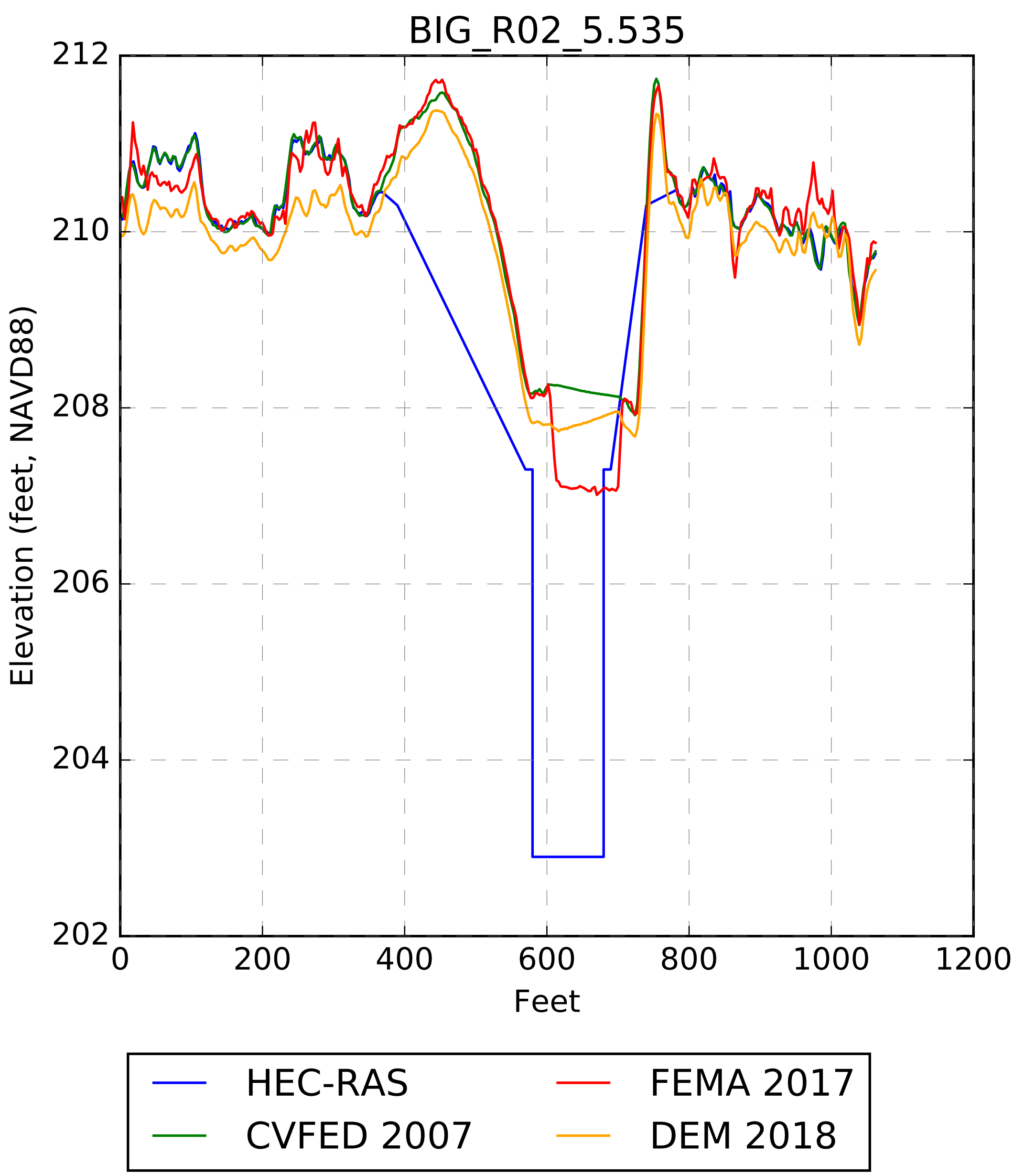
Elevation (feet, NAVD88)
Feet
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018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206
204
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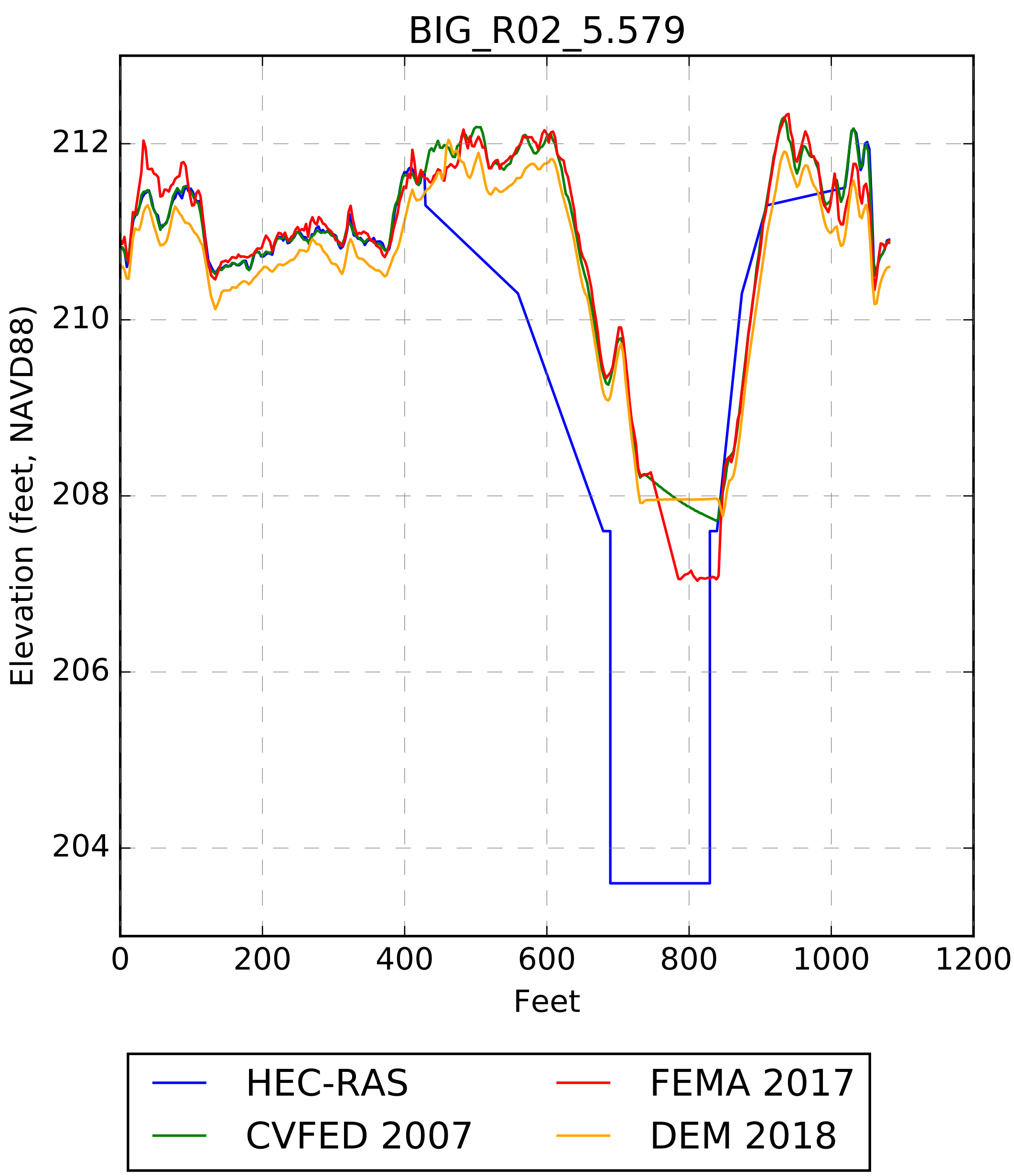
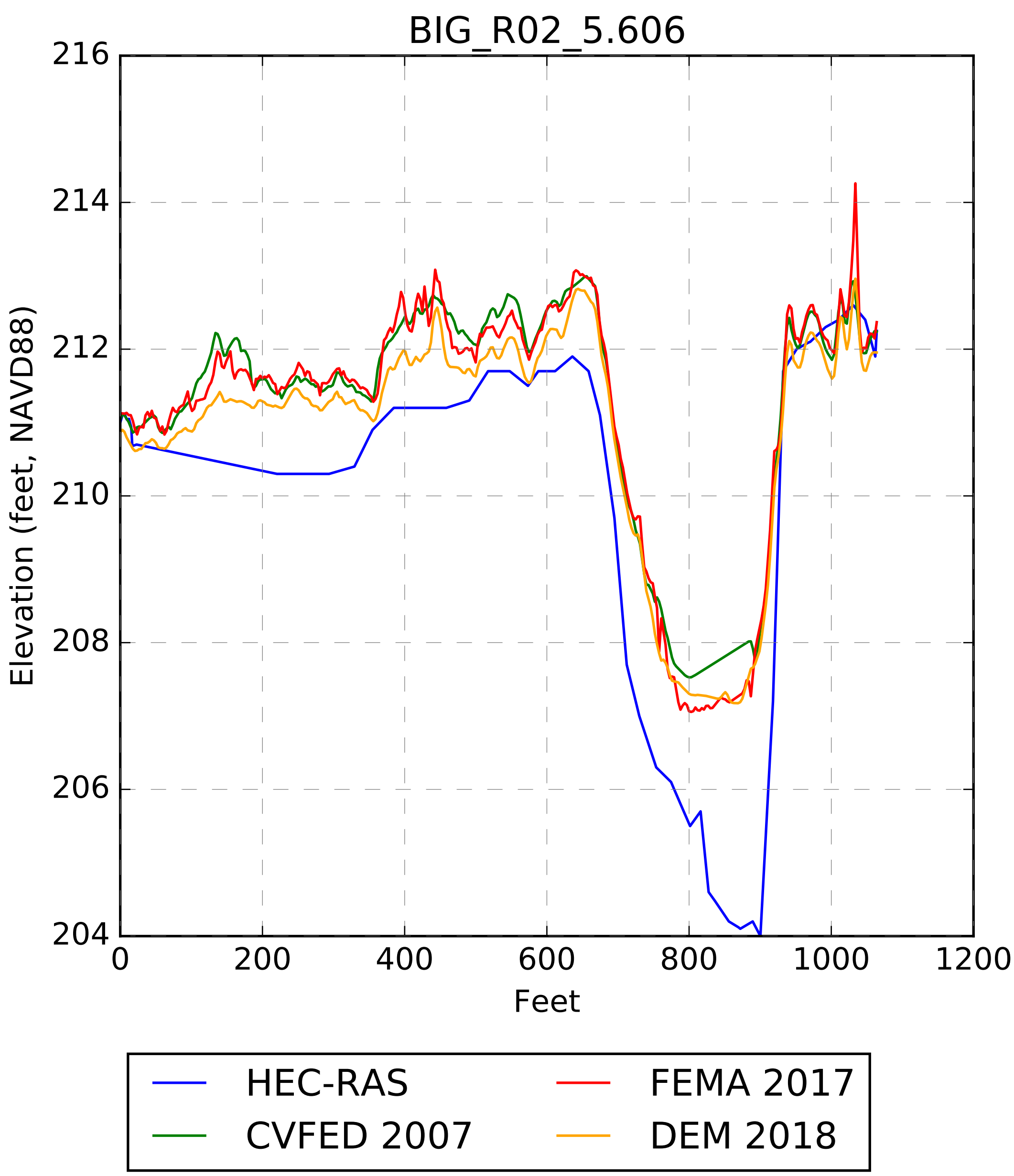
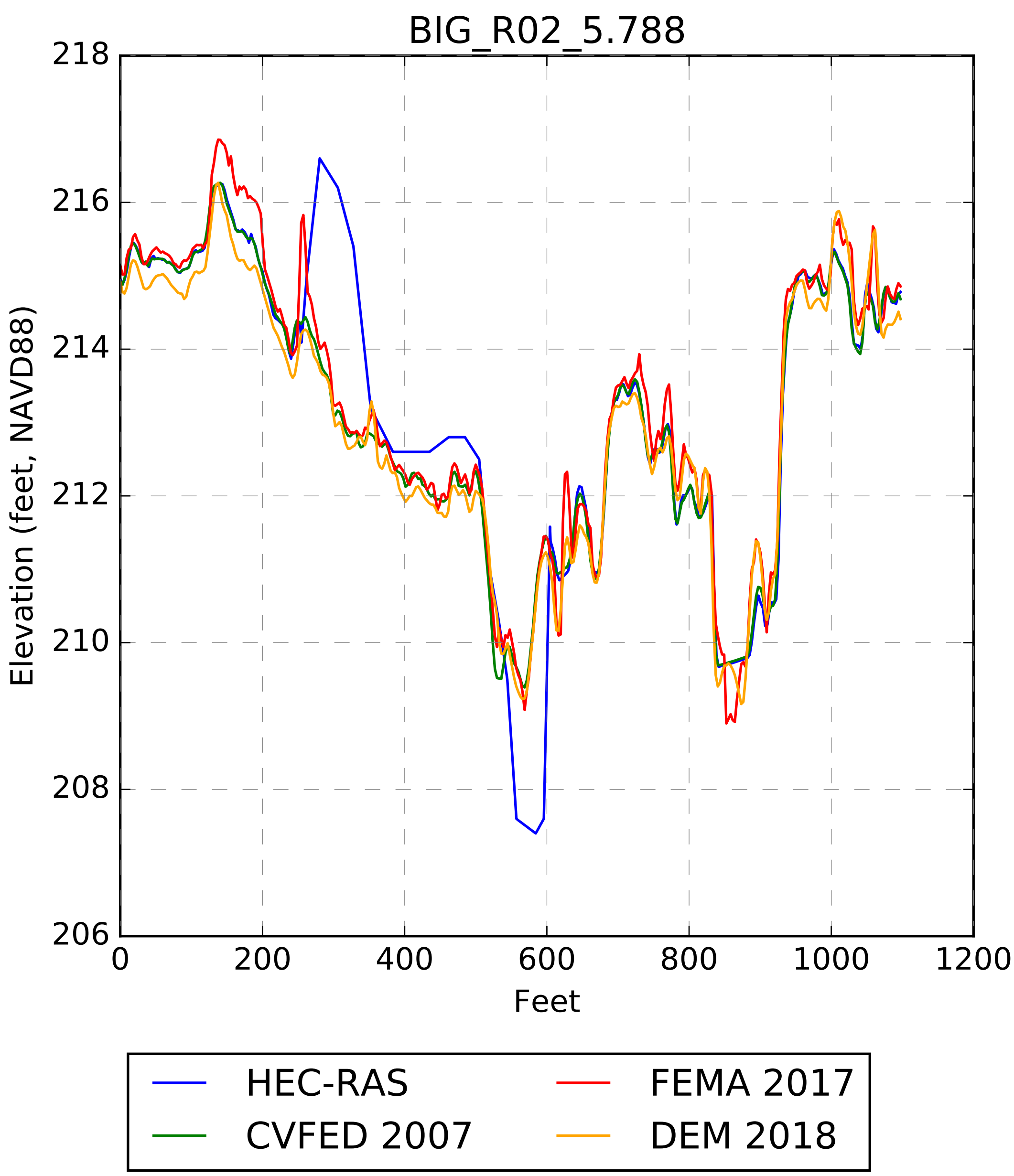
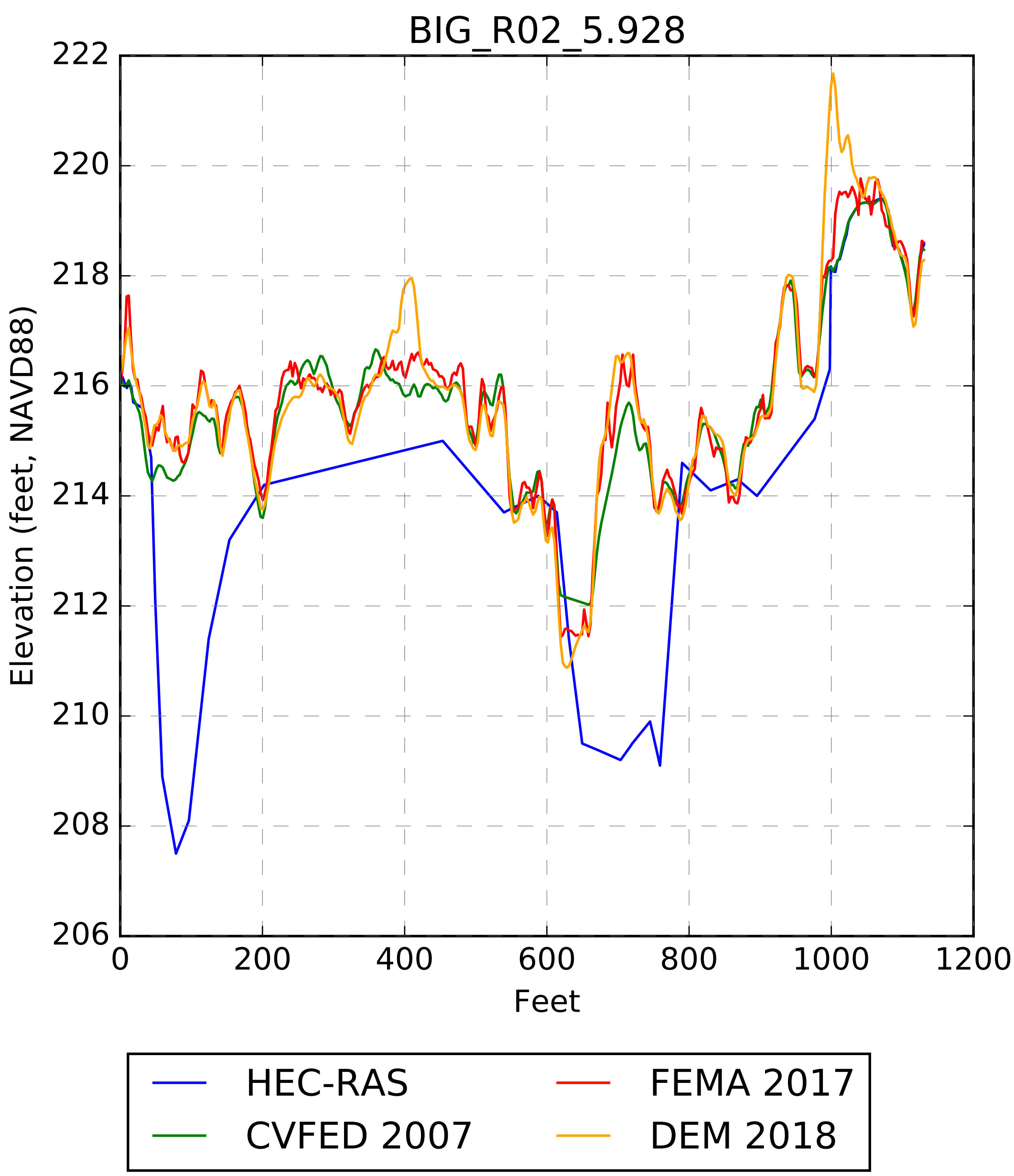
1000
1200
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018

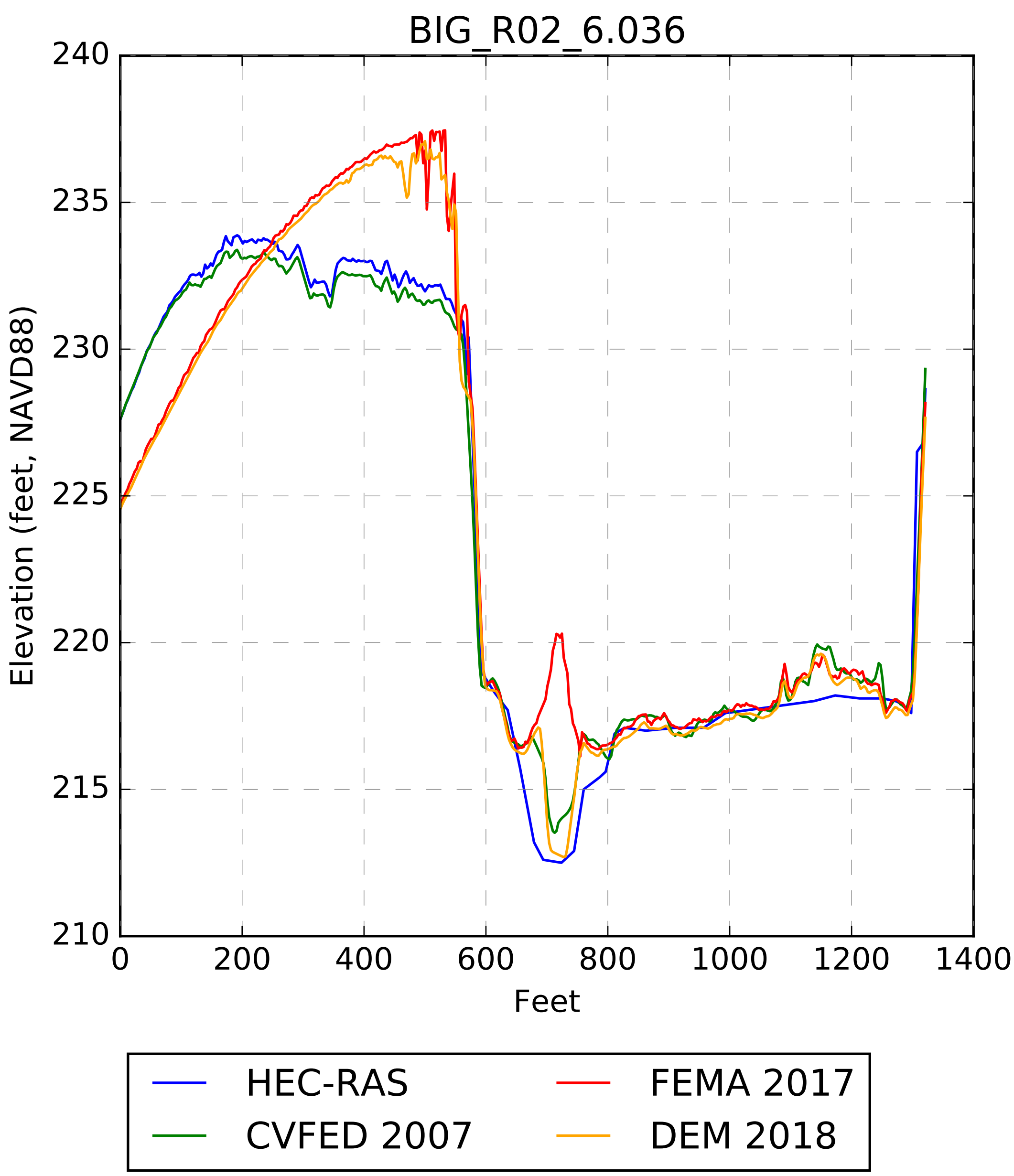

BIG_R02_5.579
Elevation (feet, NAVD88)
Feet
212
210
208
206
204
0
200
400
600
800
1000
1200
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018

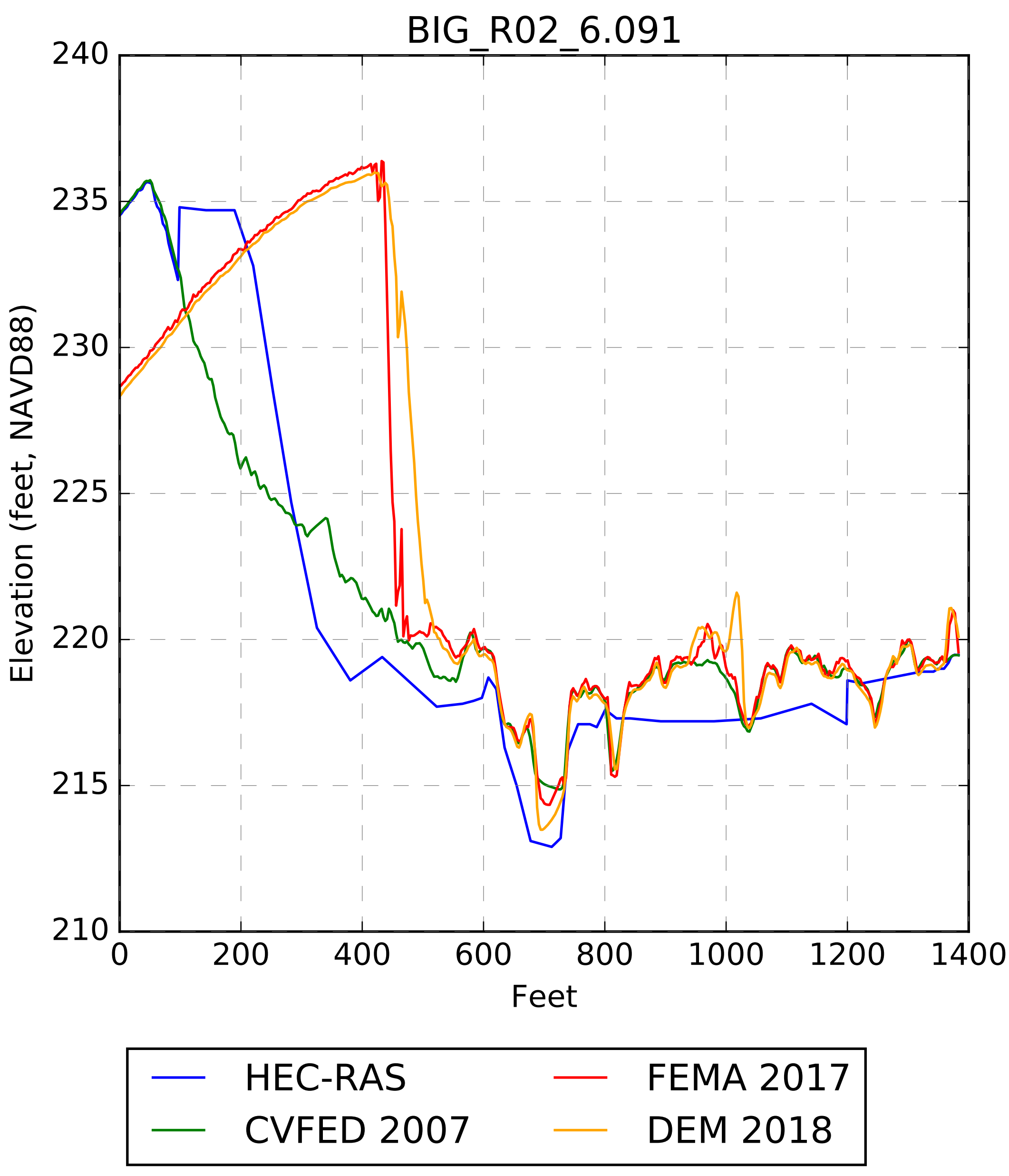

BIG_R02_5.606
Elevation (feet, NAVD88)
Feet
216
214
212
210
208
206
204
0
200
400
600
800
1000
1200
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018


BIG_R02_5.788
Elevation (feet, NAVD88)
Feet
206
208
210
212
214
216
218
0
200
400
600
800
1000
1200
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018

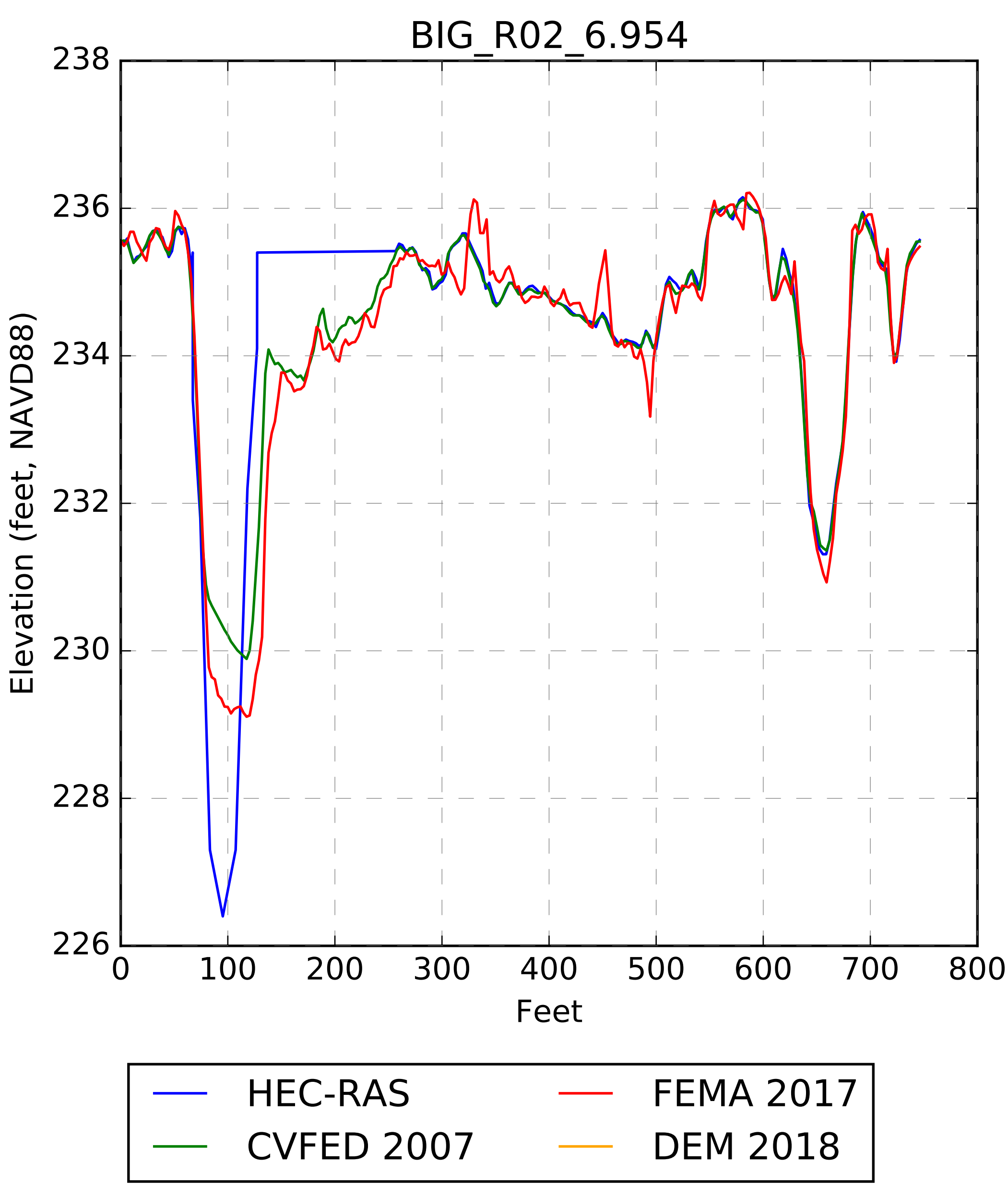


BIG_R02_5.928
Elevation (feet, NAVD88)
Feet
222
220
218
216
214
212
210
208
206
0
200
400
600
800
1000
1200
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018

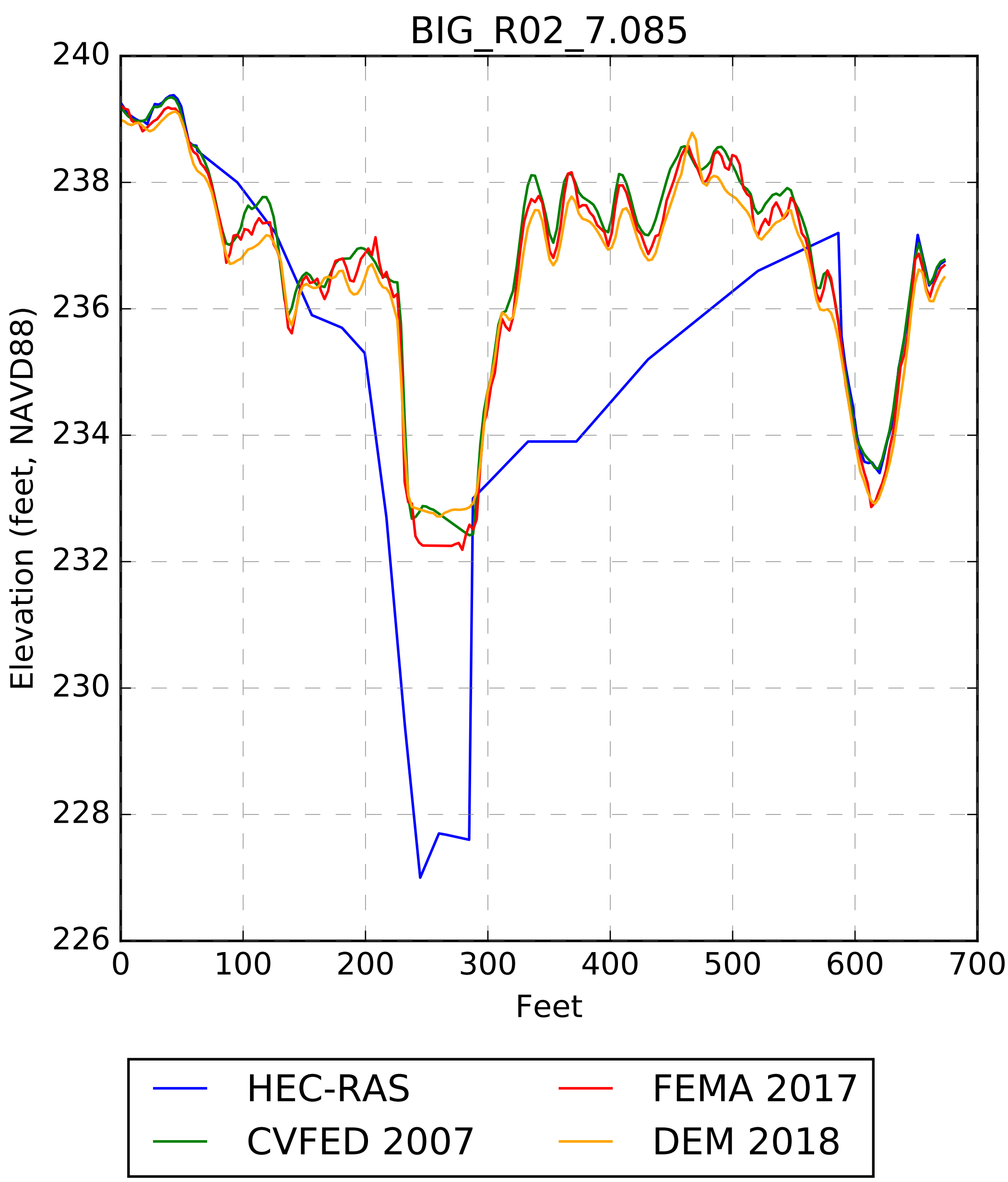

BIG_R02_6.036
240
235
230
225
220
215
210
0
200
400
600
800
1000
1200
1400
Feet
Elevation (feet, NAVD88)
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



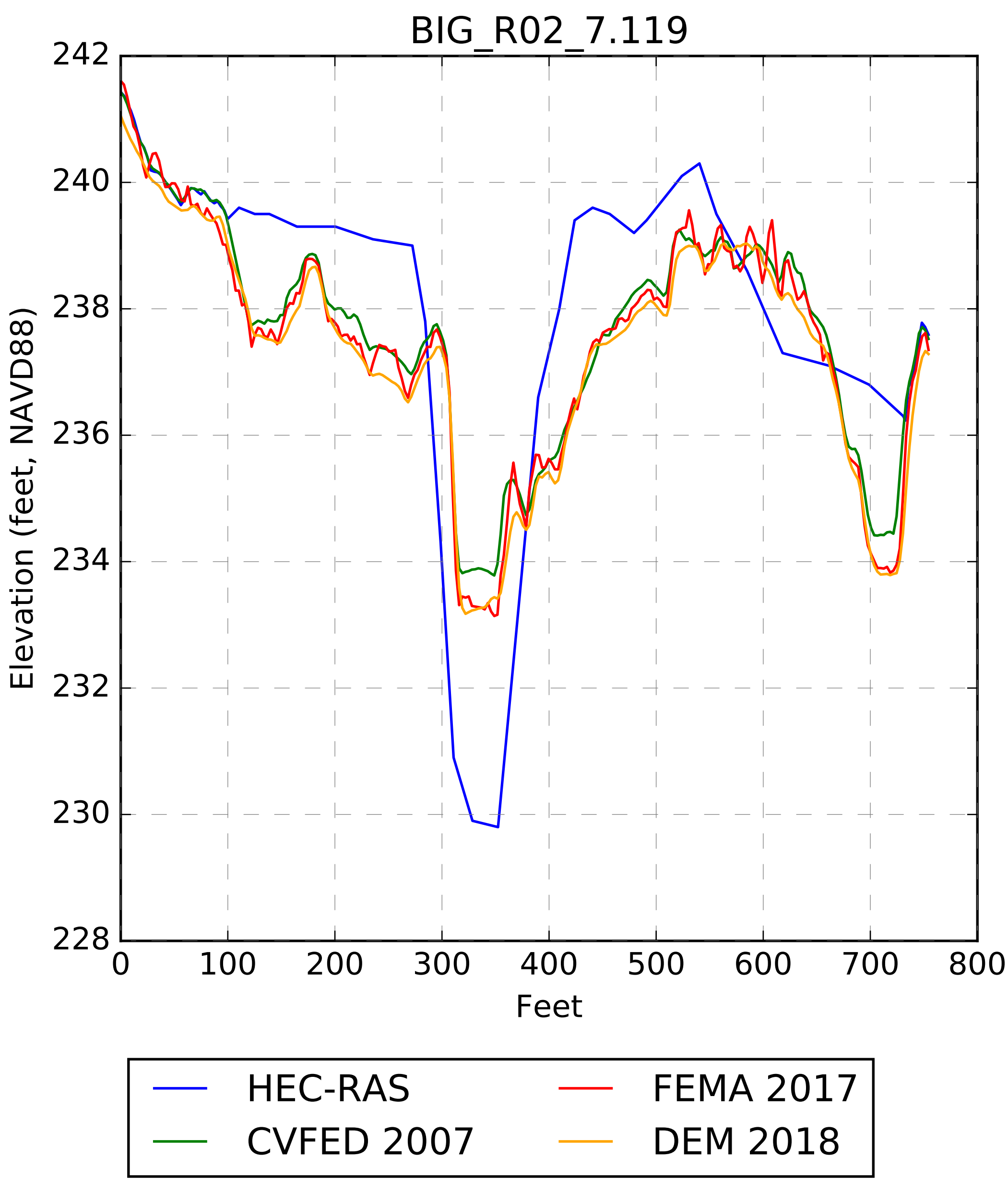
BIG_R02_6.091
240
235
230
225
220
215
210
Elevation (feet, NAVD88)
0
200
400
600
800
1000
1200
1400
Feet
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018



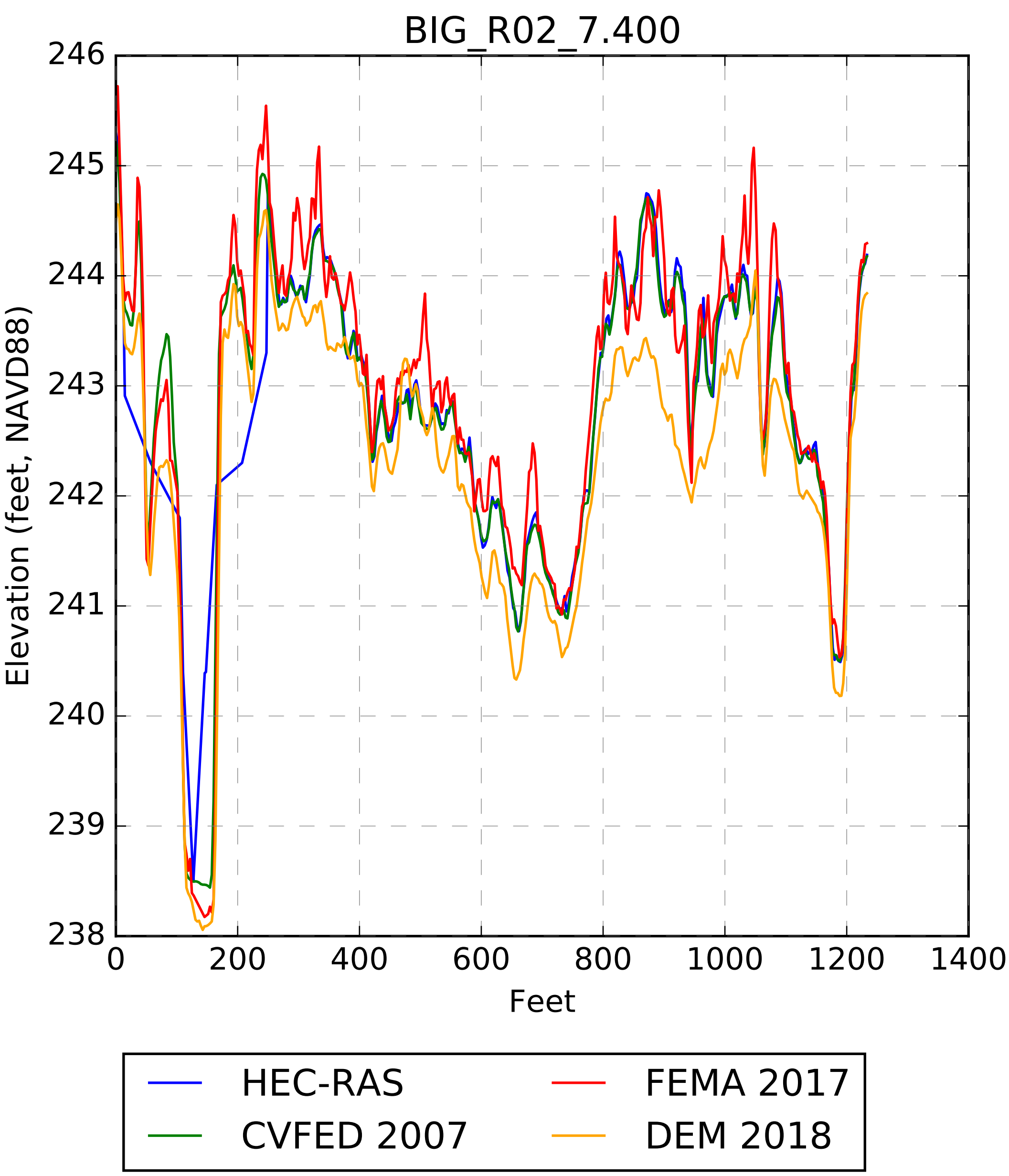
BIG_R02_6.954
238
236
234
232
230
228
226
0
100
200
300
400
500
600
700
800
Elevation (feet, NAVD88)
Feet
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018



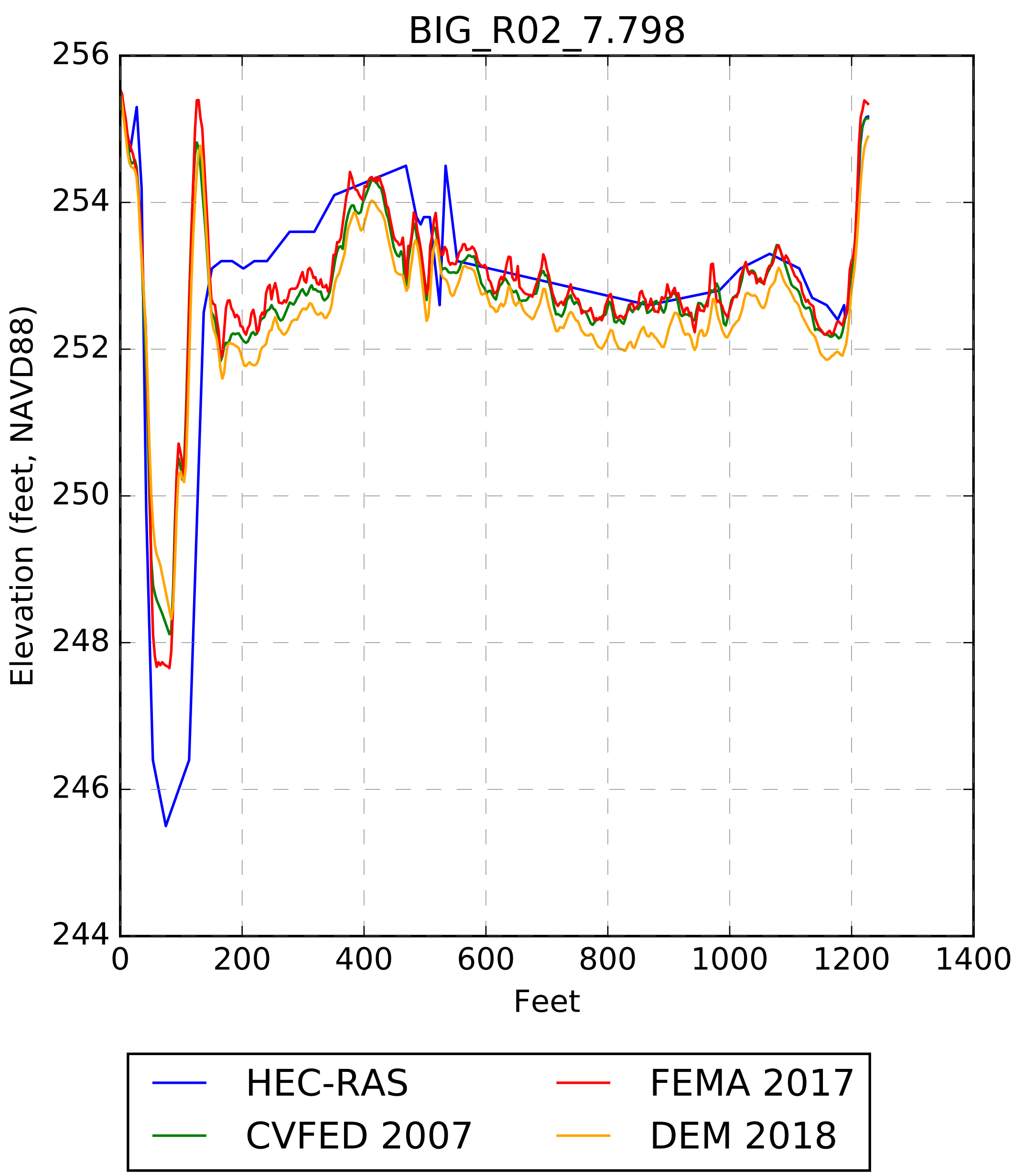
BIG_R02_7.085
Elevation (feet, NAVD88)
Feet
240
238
236
234
232
230
228
226
0
100
200
300
400
500
600
700
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



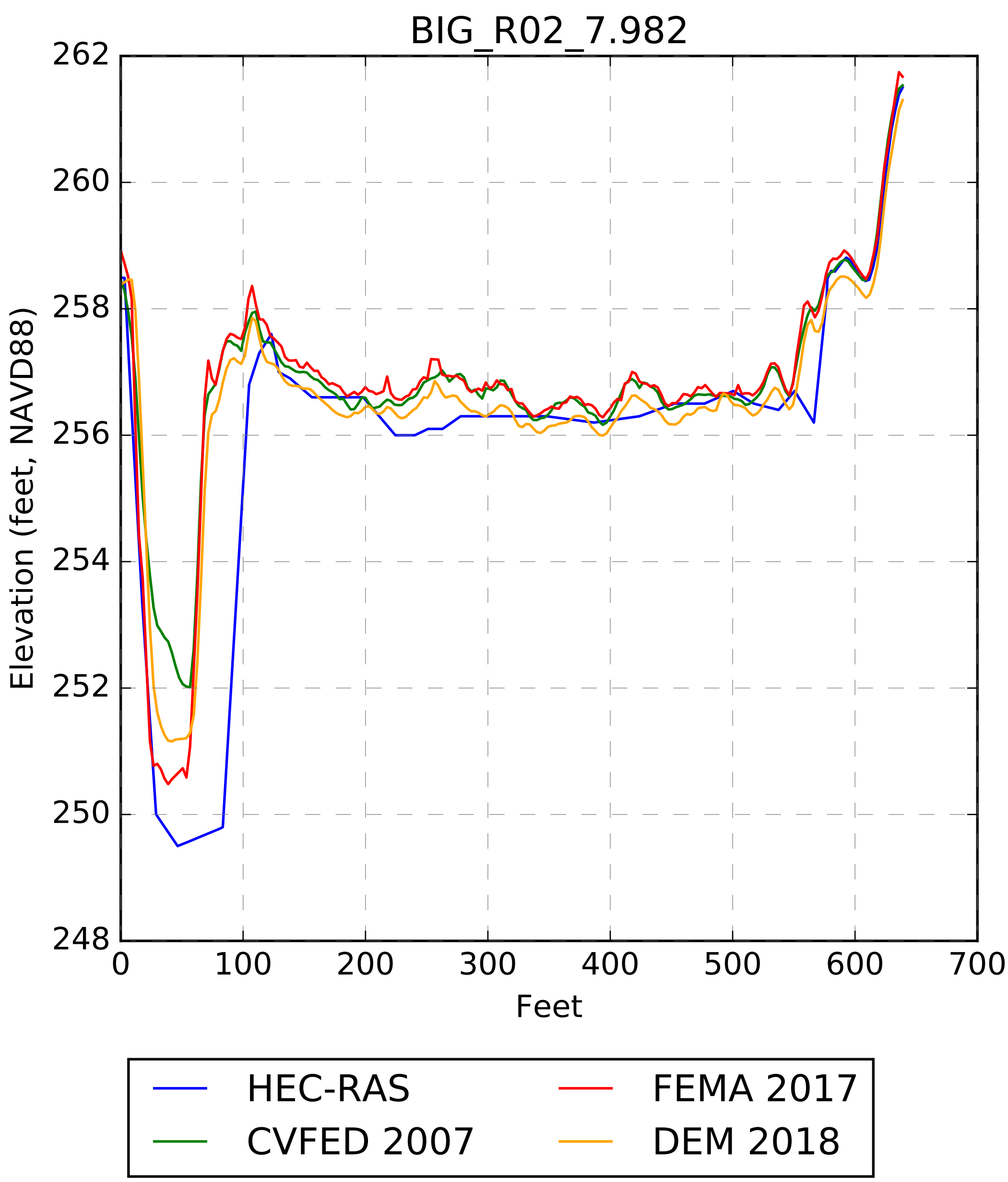
BIG_R02_7.119
Elevation (feet, NAVD88)
Feet
242
240
238
236
234
232
230
228
0
100
200
300
400
500
600
700
800
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018

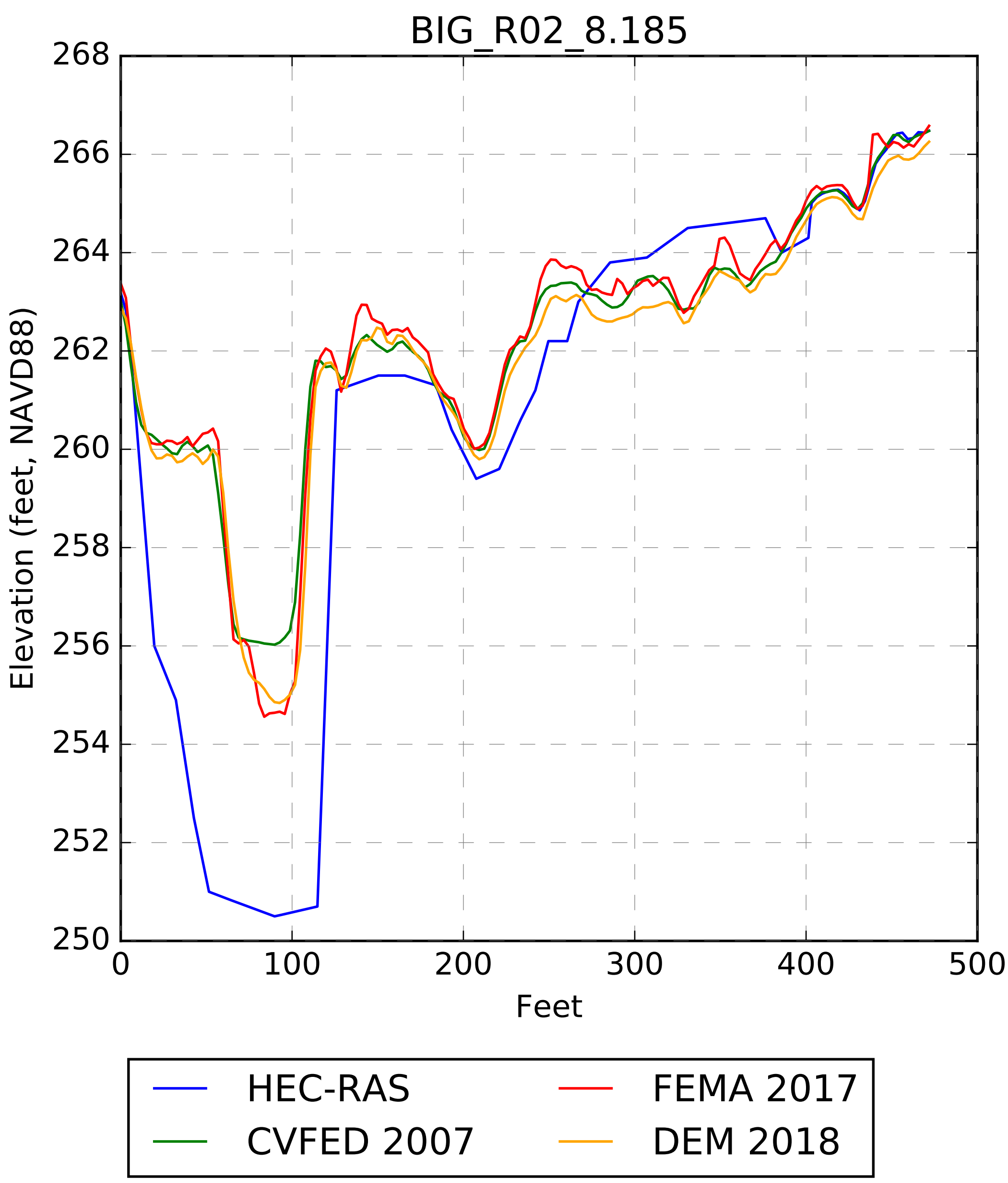


BIG_R02_7.400
246
245
244
243
242
241
240
239
238
0
200
400
600
800
1000
1200
1400
Feet
Elevation (feet, NAVD88)
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



BIG_R02_7.798
Elevation (feet, NAVD88)
256
254
252
250
248
246
244
0
200
400
600
800
1000
1200
1400
Feet
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018

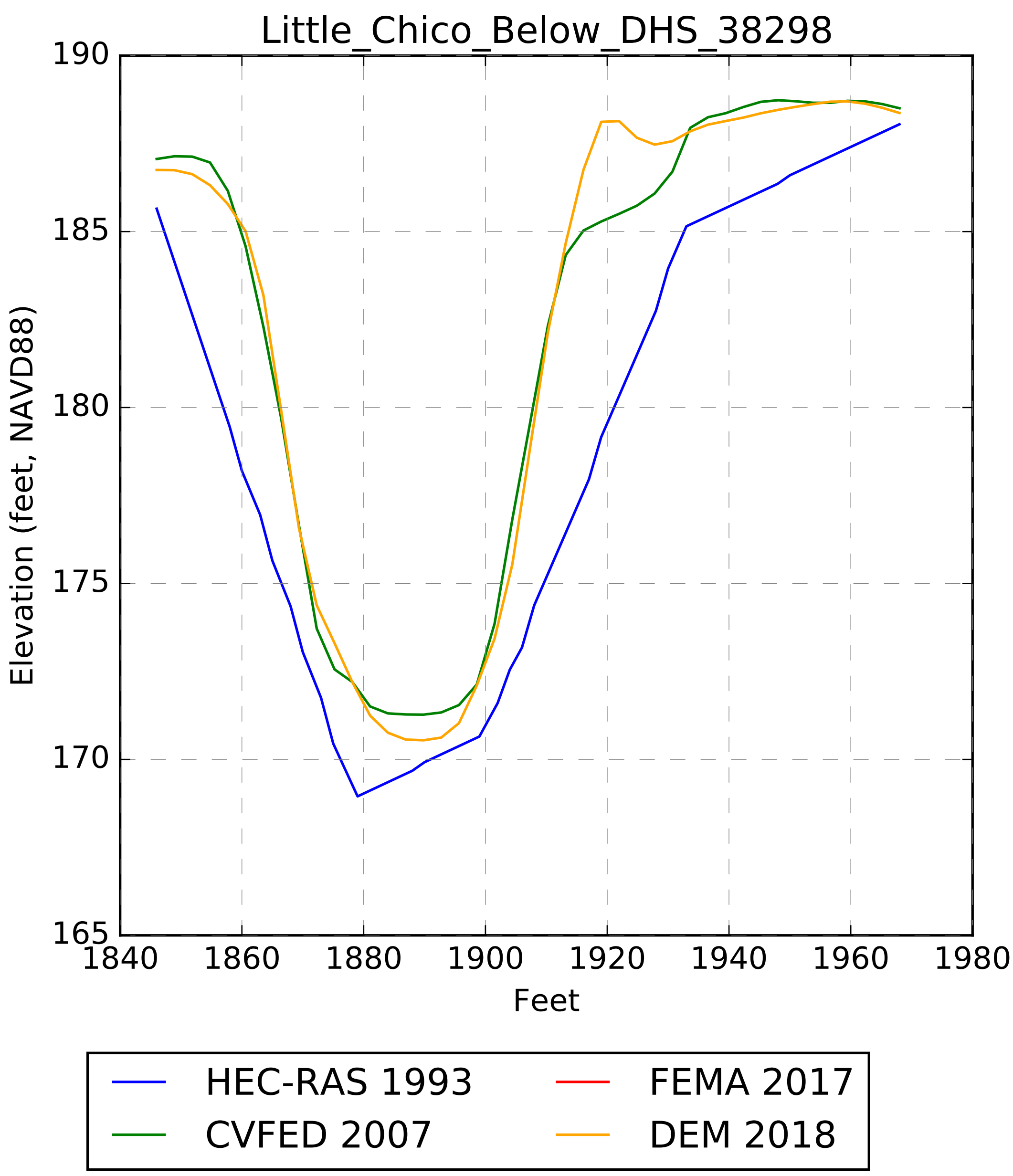

BIG_R02_7.982
Elevation (feet, NAVD88)
Feet
262
260
258
256
254
252
250
248
0
100
200
300
400
500
600
700
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018


BIG_R02_8.185
Elevation (feet, NAVD88)
Feet
268
266
264
262
260
258
256
254
252
250
0
100
200
300
400
500
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018

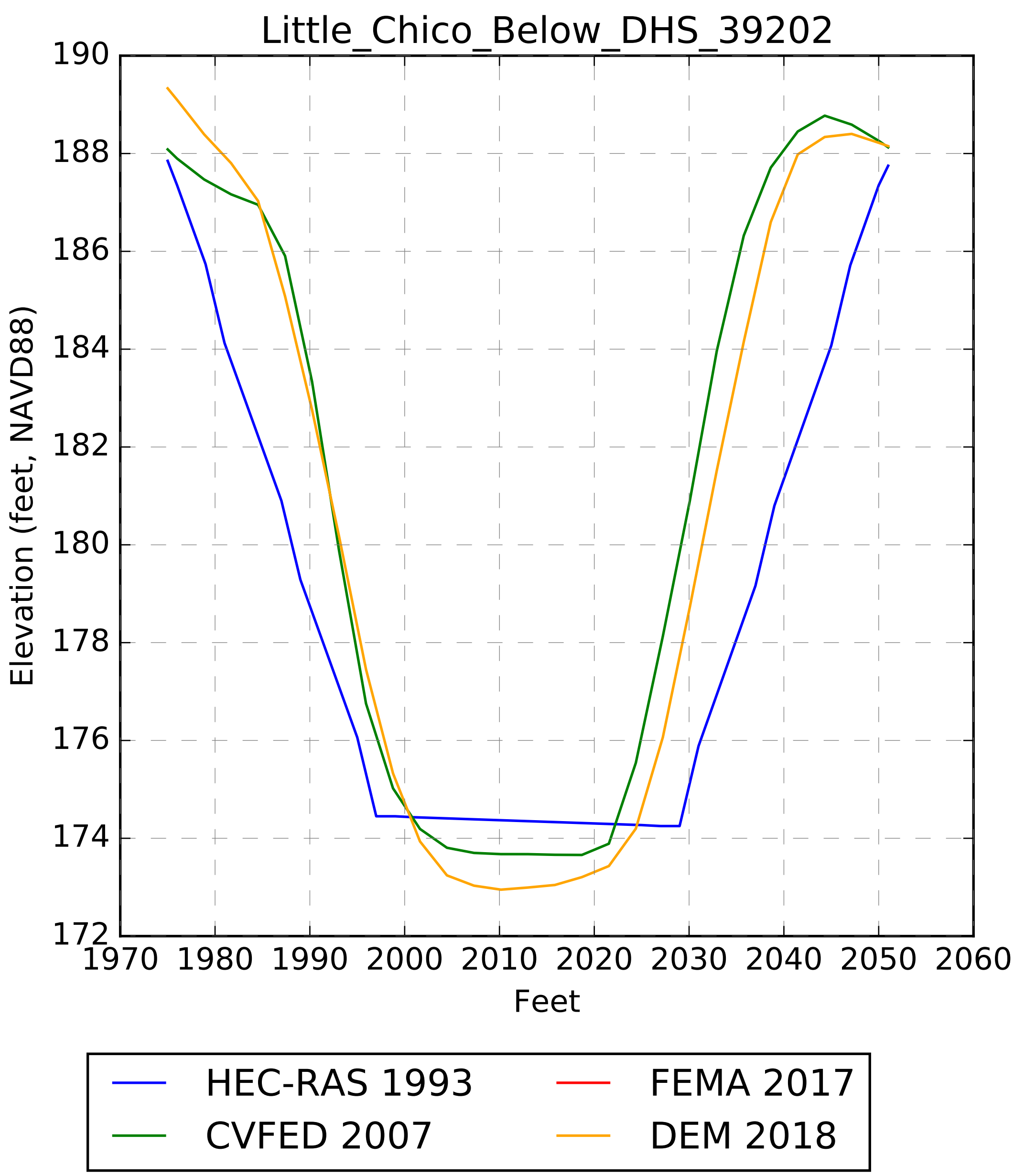
City of Chico

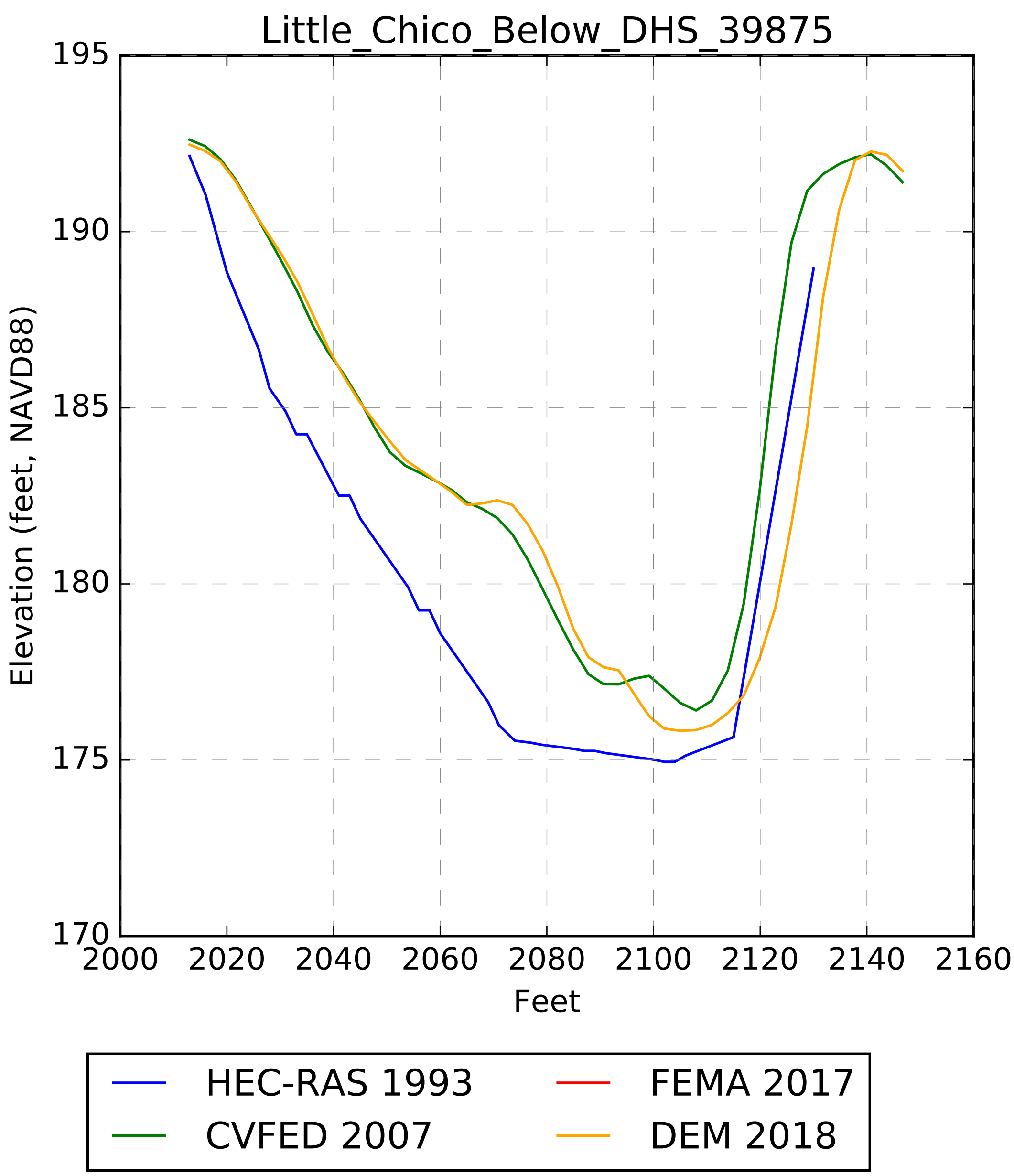
Storm Water Master Plan

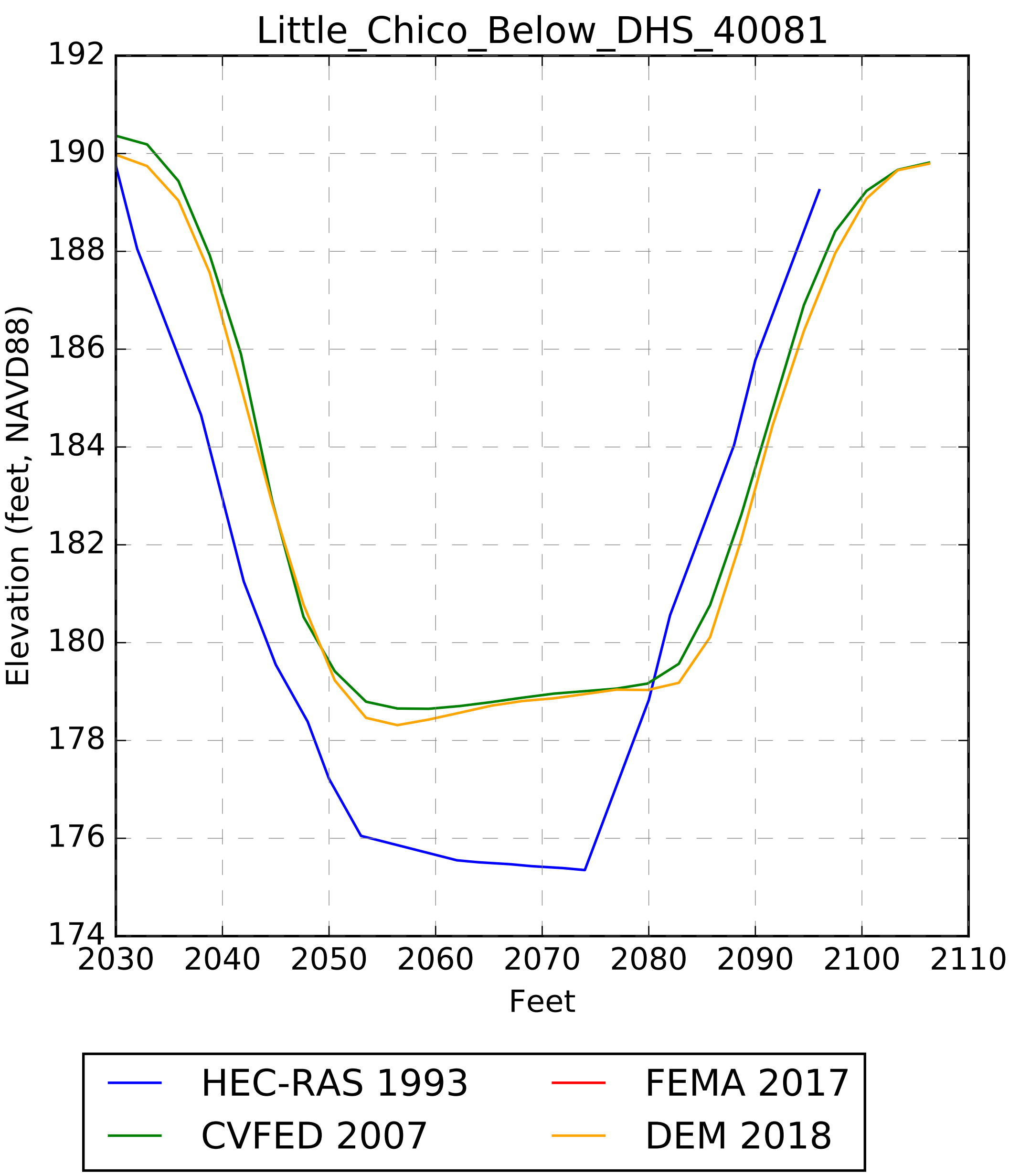
Appendix F.2 – Little Chico Creek Cross Section Comparisons

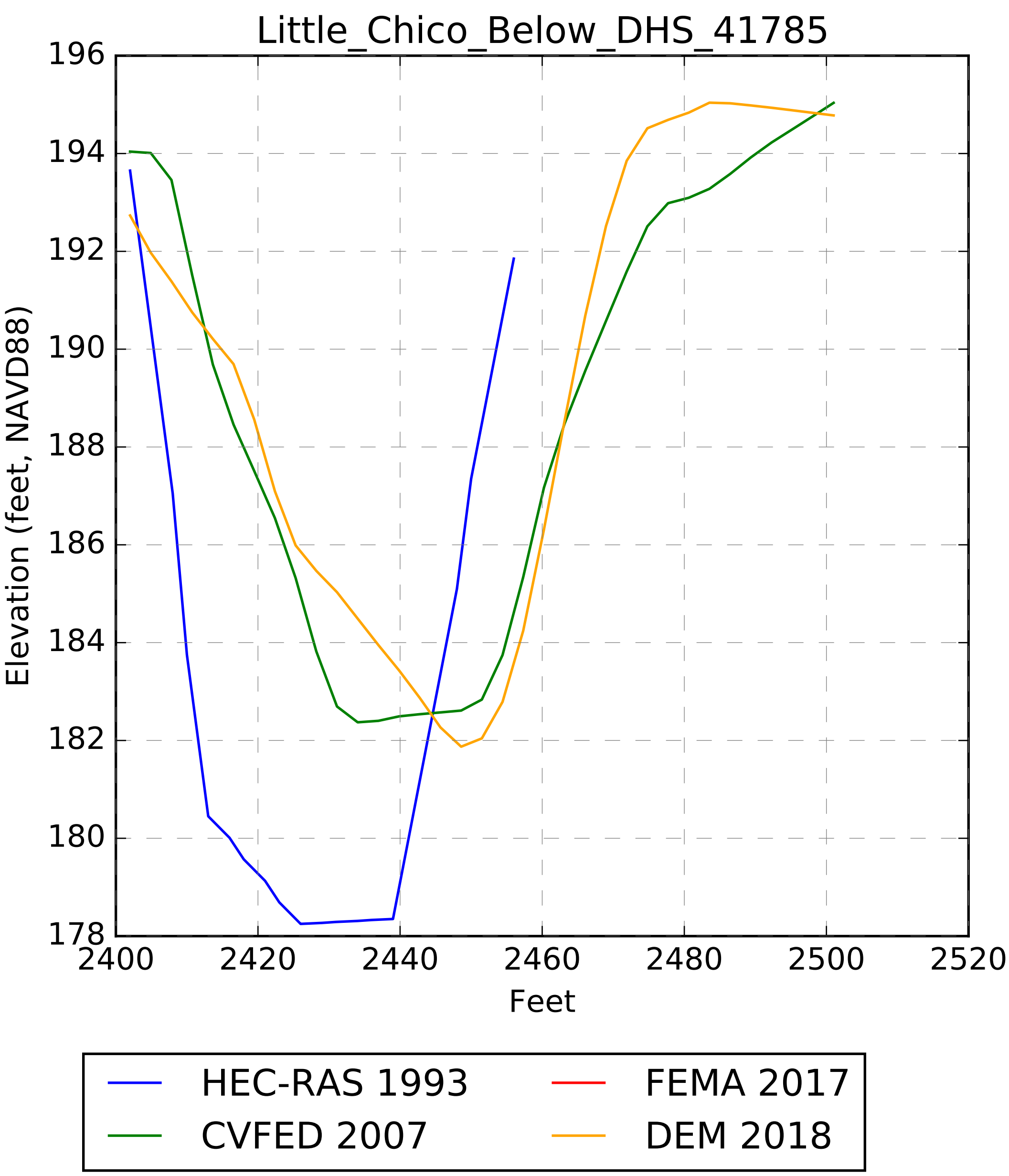


Little_Chico_Below_DHS_38298
190
185
180
175
170
165
1840
1860
1880
1900
1920
1940
1960
1980
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018

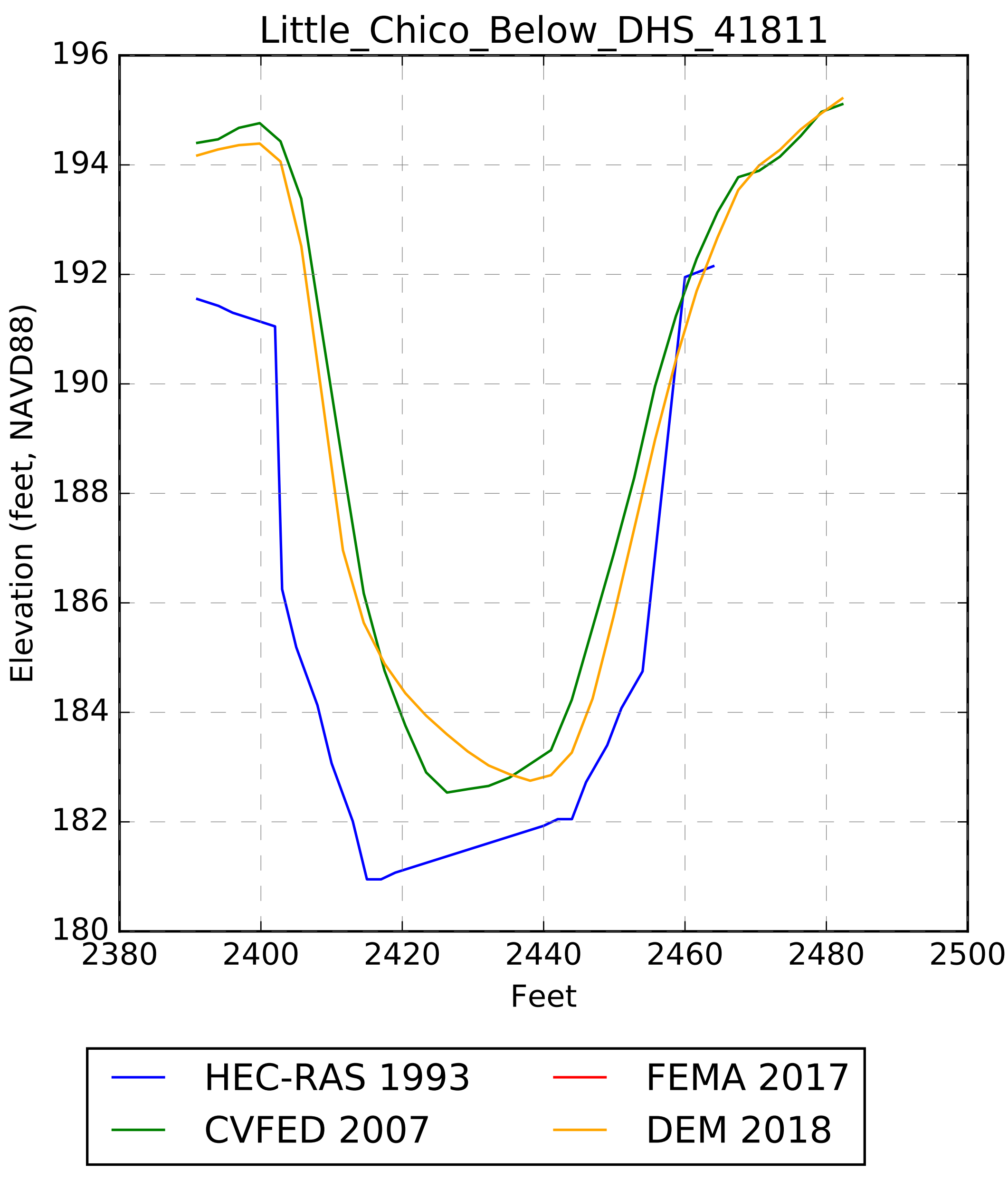

Little_Chico_Below_DHS_39202
Elevation (feet, NAVD88)
190
188
186
184
182
180
178
176
174
172
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
Feet
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018


Little_Chico_Below_DHS_39875
195
190
185
180
175
170
2000
2020
2040
2060
2080
2100
2120
2140
2160
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

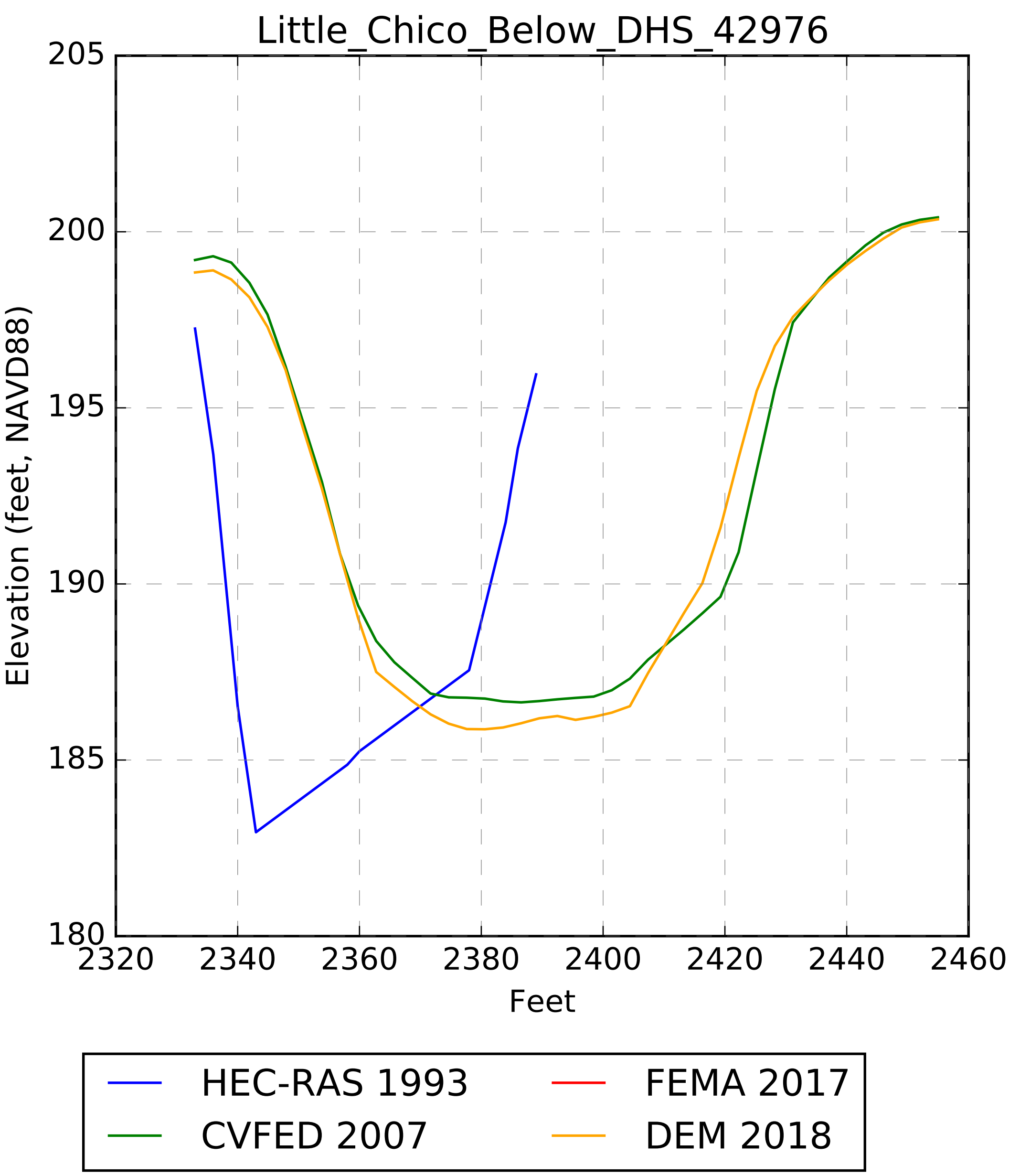

Little_Chico_Below_DHS_40081
Elevation (feet, NAVD88)
Feet
192
190
188
186
184
182
180
178
176
174
2030
2040
2050
2060
2070
2080
2090
2100
2110
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018



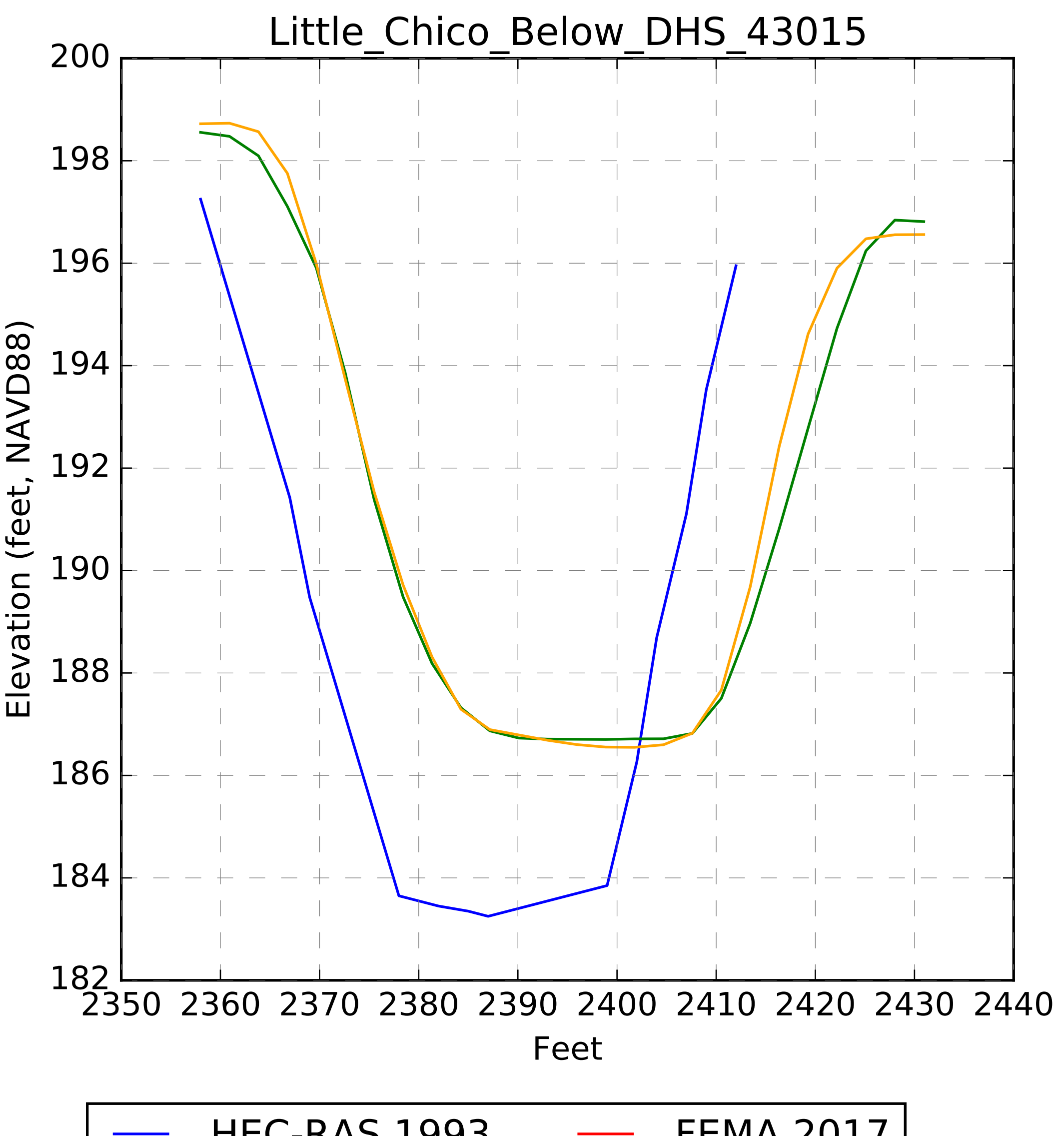
Little_Chico_Below_DHS_41785
196
194
192
190
188
186
184
182
180
178
2400
2420
2440
2460
2480
2500
2520
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018



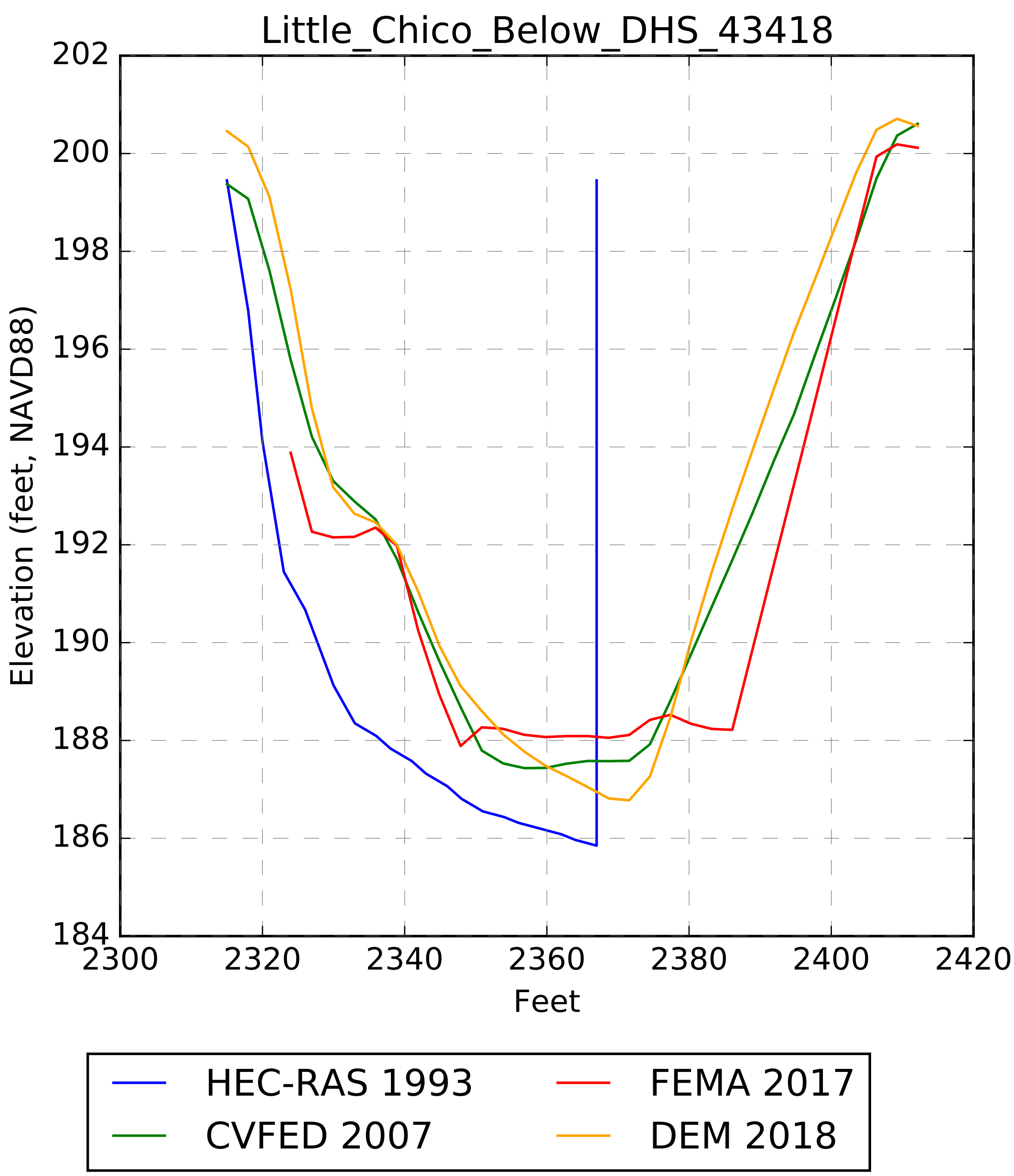
Little_Chico_Below_DHS_41811
196
194
192
190
188
186
184
182
180
2380
2400
2420
2440
2460
2480
2500
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

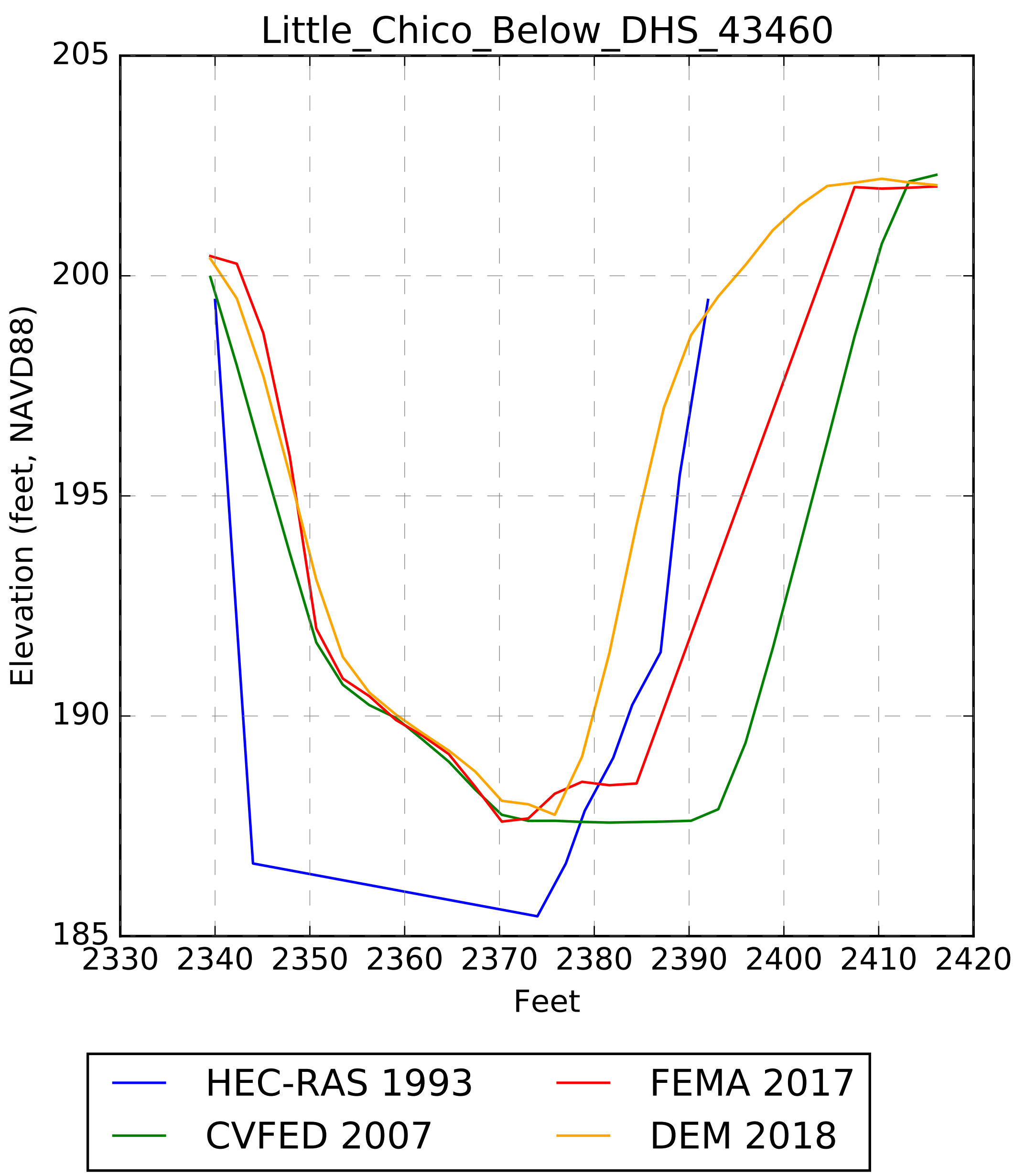


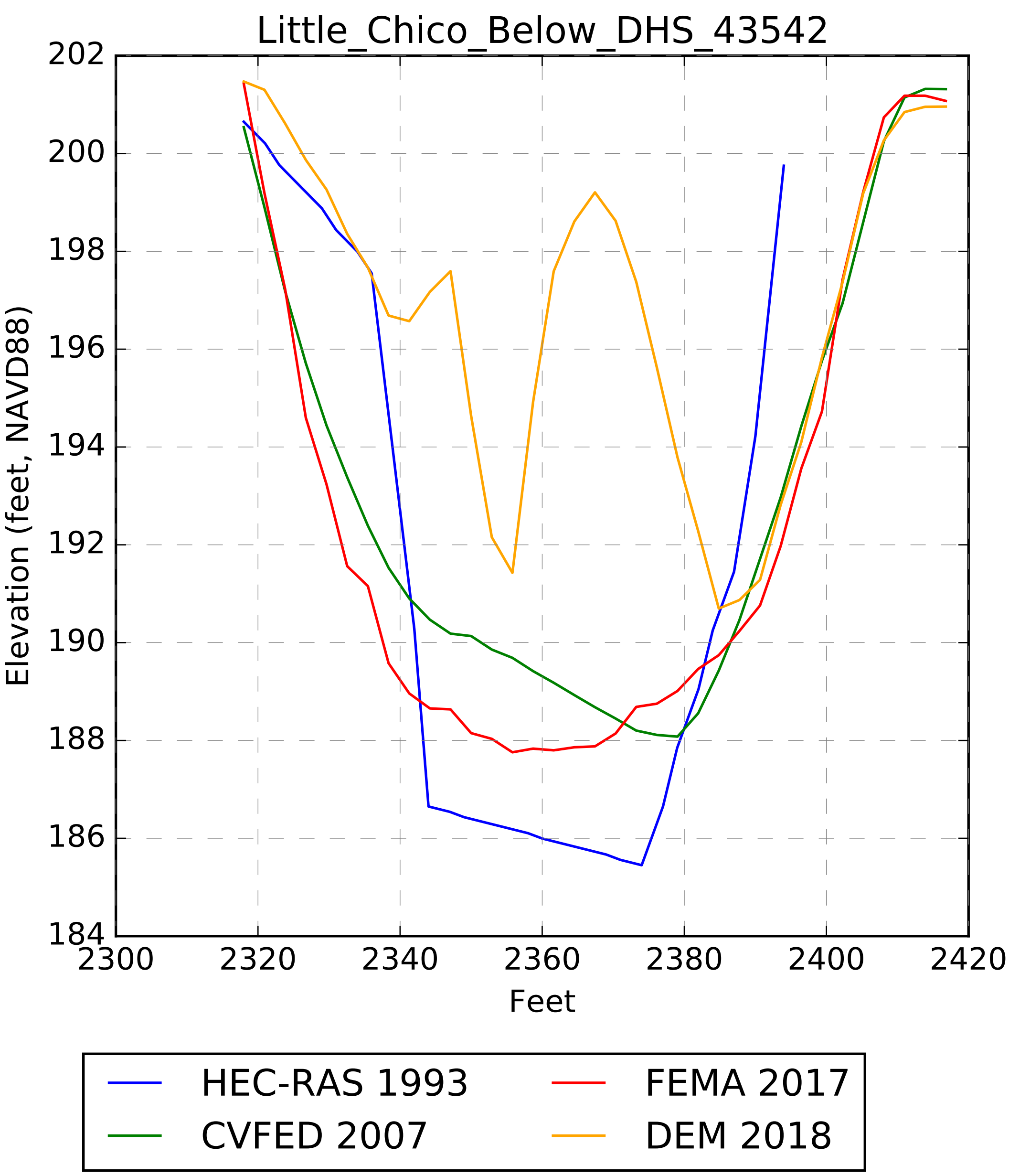
Little_Chico_Below_DHS_42976
Elevation (feet, NAVD88)
Feet
205
200
195
190
185
180
2320
2340
2360
2380
2400
2420
2440
2460
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018



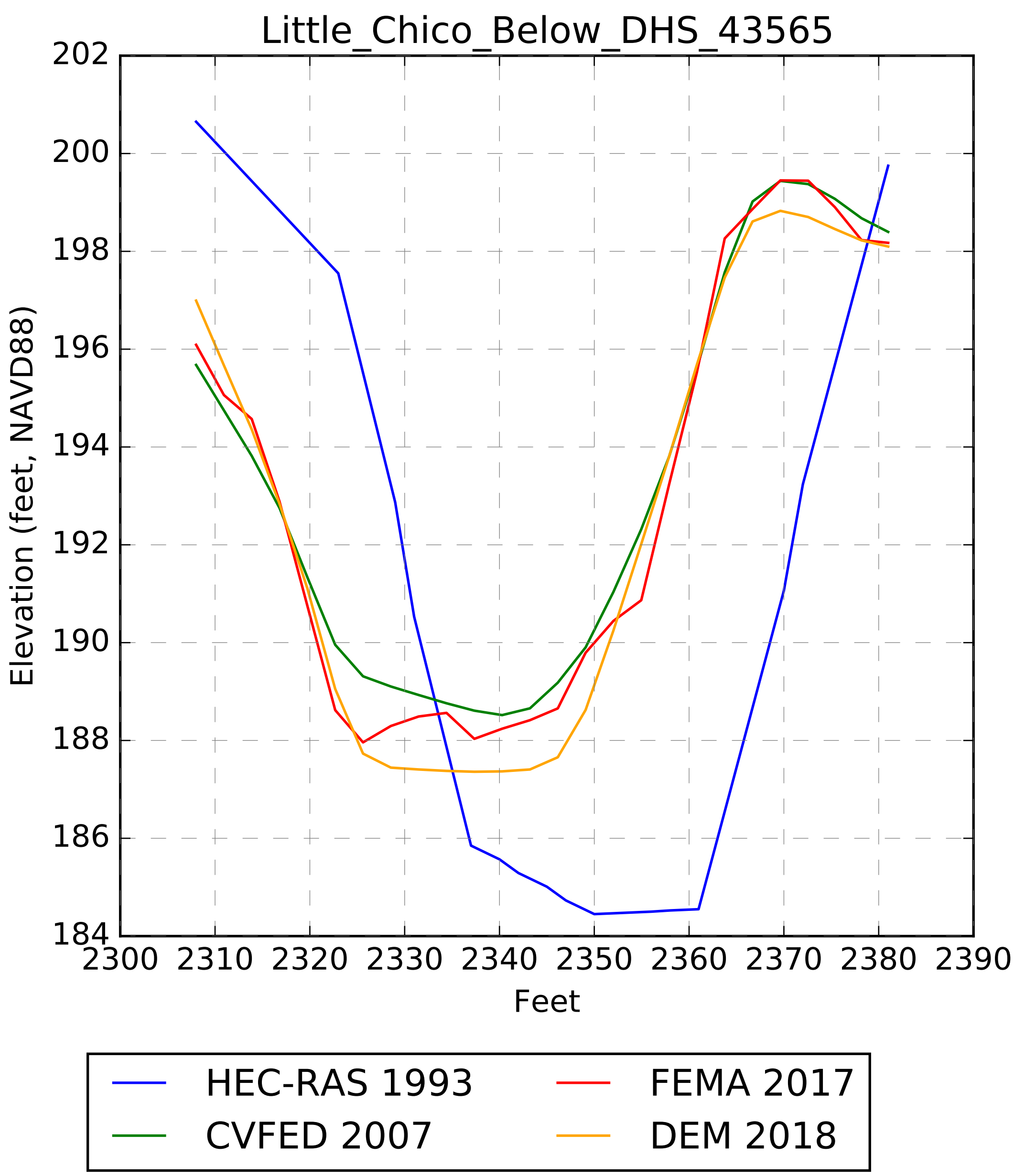
Little_Chico_Below_DHS_43015
200
198
196
194
192
190
188
186
184
182
2350
2360
2370
2380
2390
2400
2410
2420
2430
2440
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

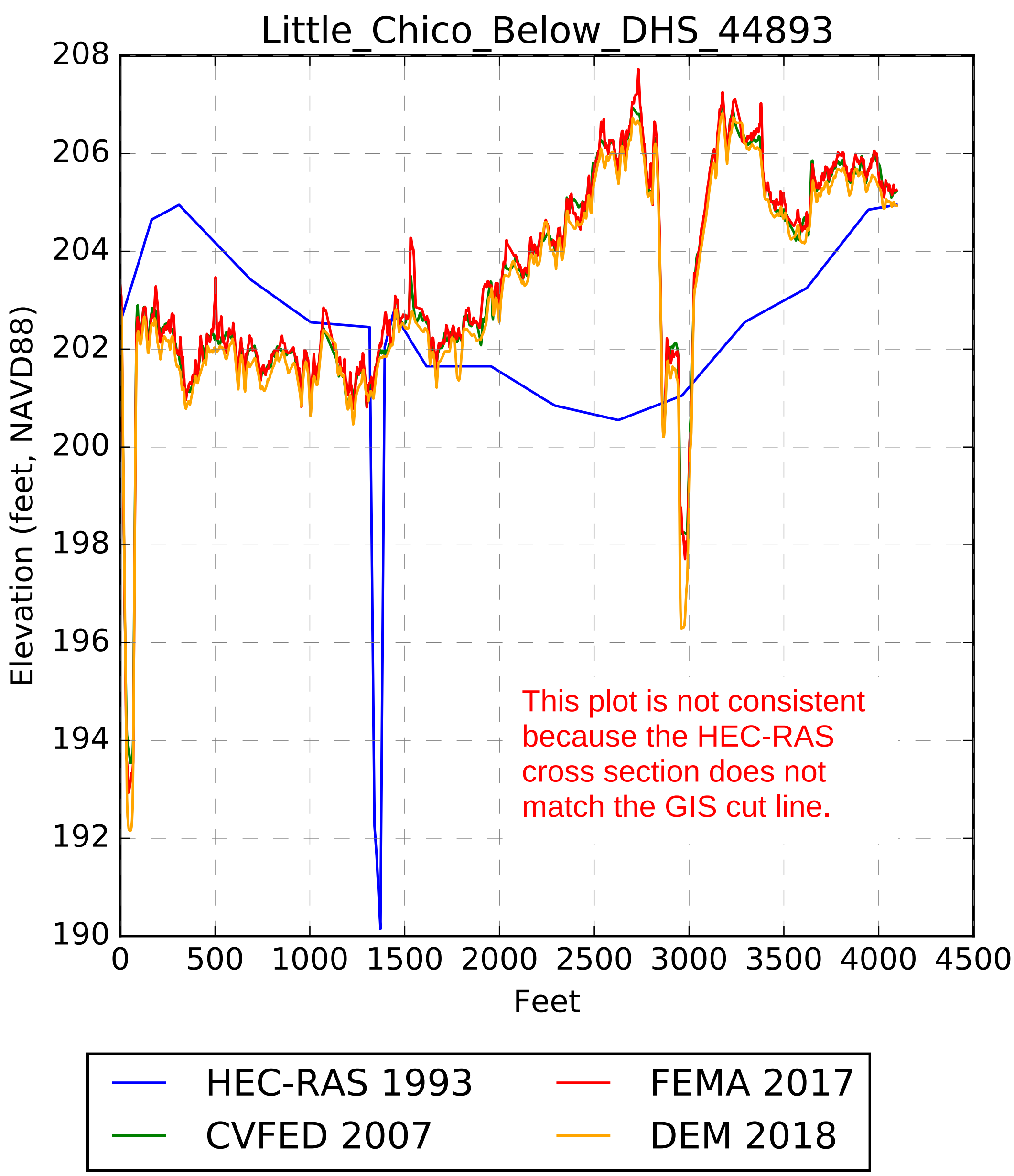

Little_Chico_Below_DHS_43418
202
200
198
196
194
192
190
188
186
184
Elevation (feet, NAVD88)
2300
2320
2340
2360
2380
2400
2420
Feet
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

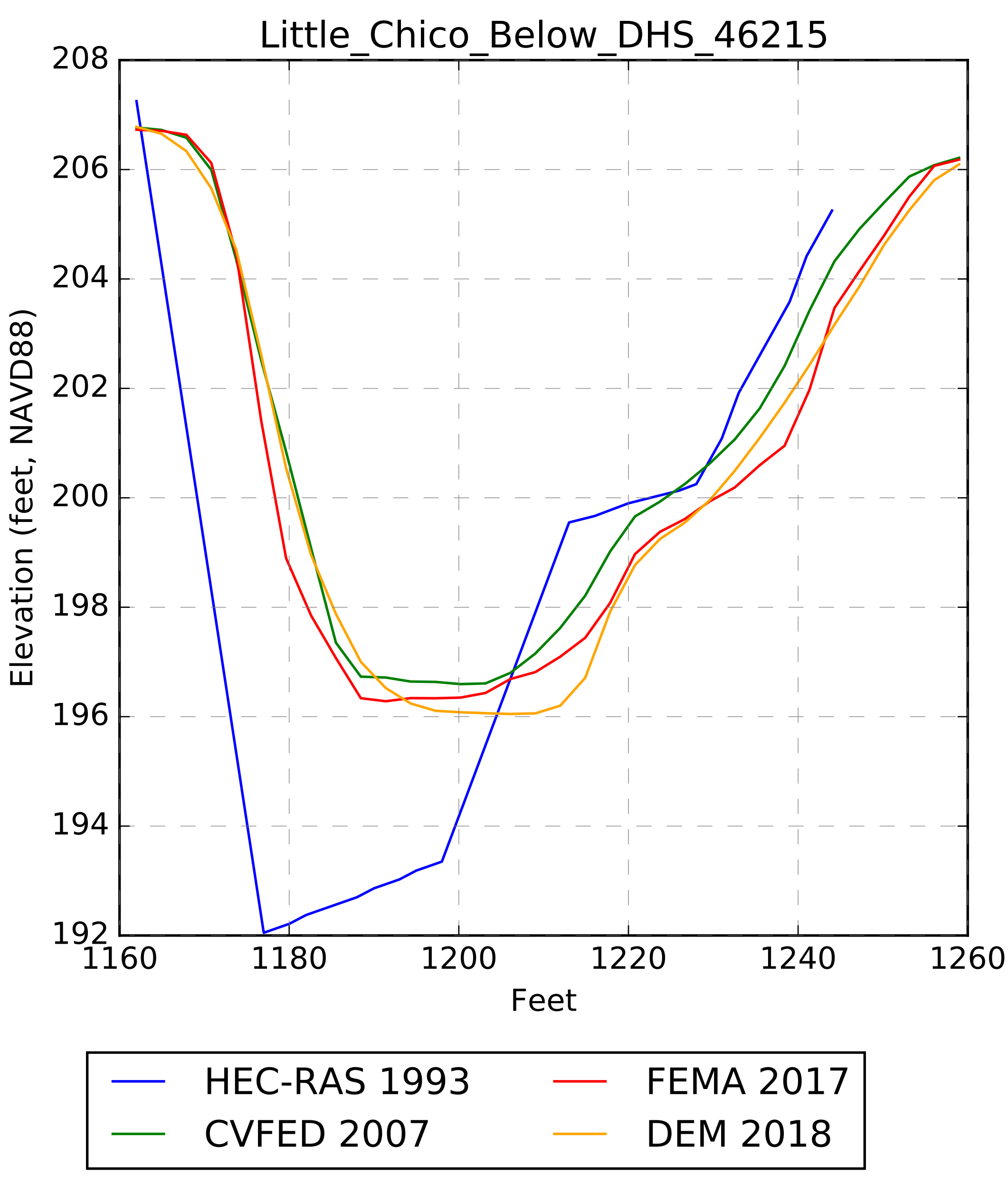

Little_Chico_Below_DHS_43460
205
200
195
190
185
2330
2340
2350
2360
2370
2380
2390
2400
2410
2420
Elevation (feet, NAVD88)
Feet
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018

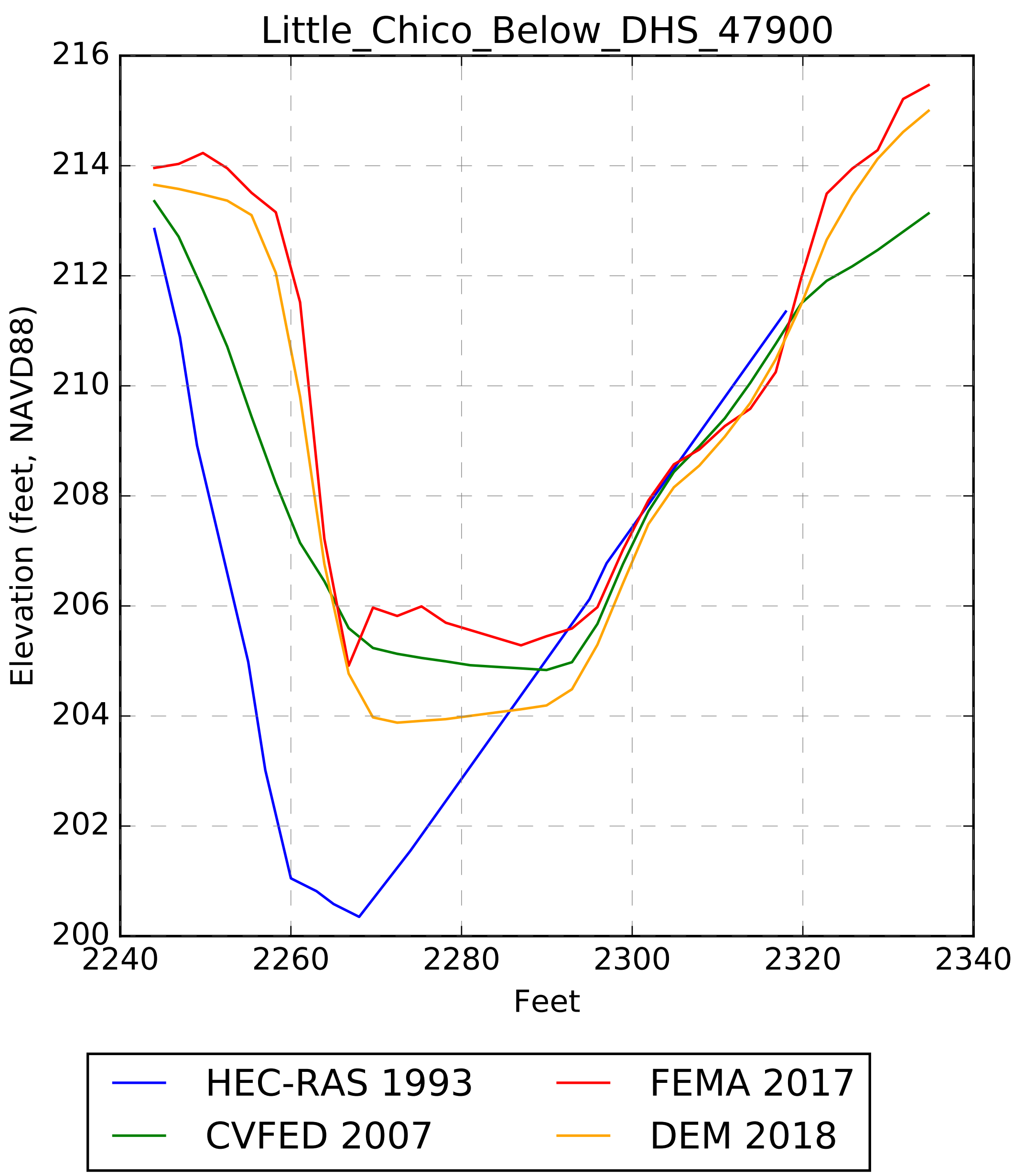


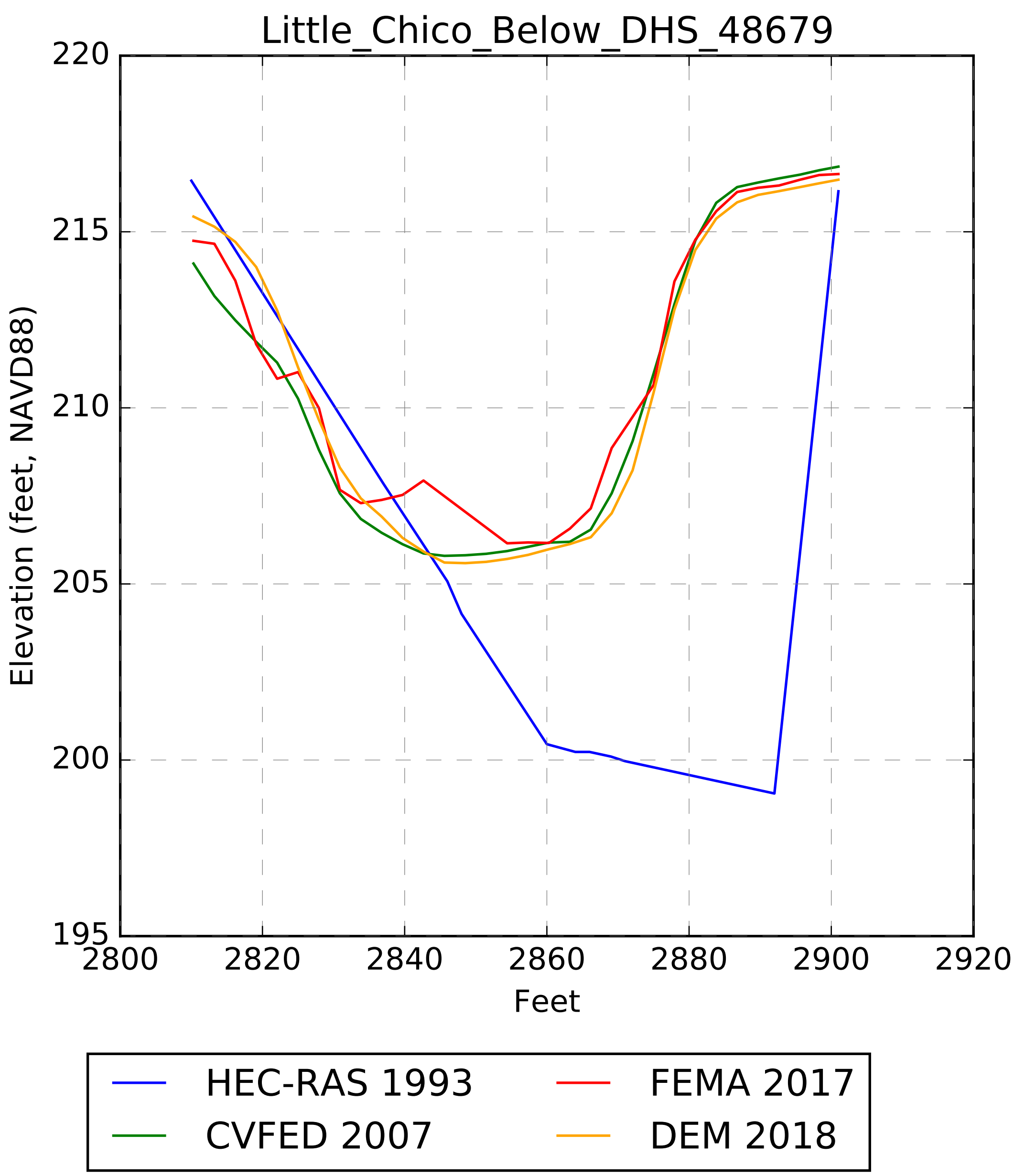
Little_Chico_Below_DHS_43542
Elevation (feet, NAVD88)
Feet
184
186
188
190
192
194
196
198
200
202
2300
2320
2340
2360
2380
2400
2420
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

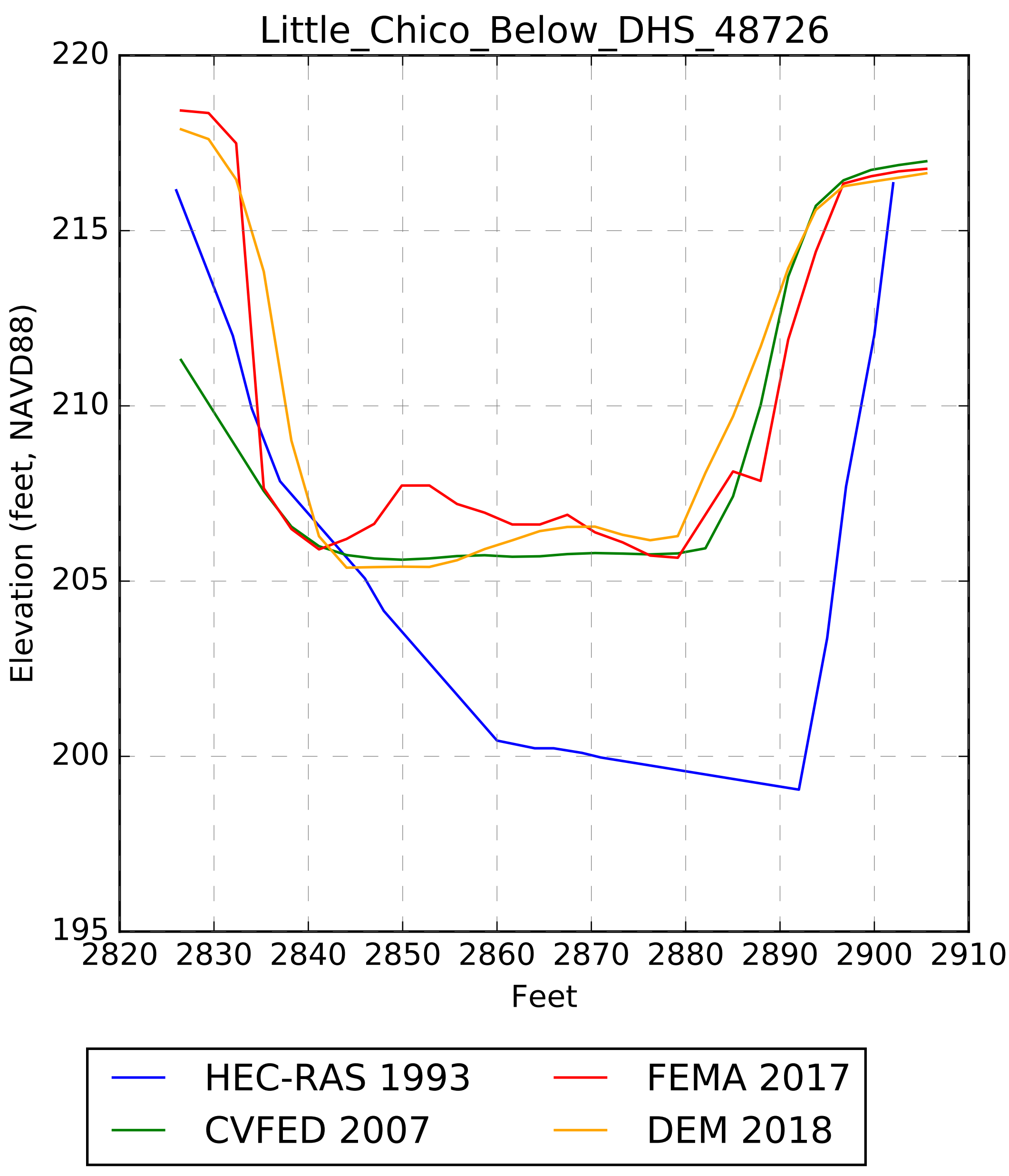

Little_Chico_Below_DHS_43565
Elevation (feet, NAVD88)
202
200
198
196
194
192
190
188
186
184
2300
2310
2320
2330
2340
2350
2360
2370
2380
2390
Feet
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018


Little_Chico_Below_DHS_44893
Elevation (feet, NAVD88)
208
206
204
202
200
198
196
194
192
190
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Feet
This plot is not consistent
because the HEC-RAS
cross section does not
match the GIS cut line.
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018

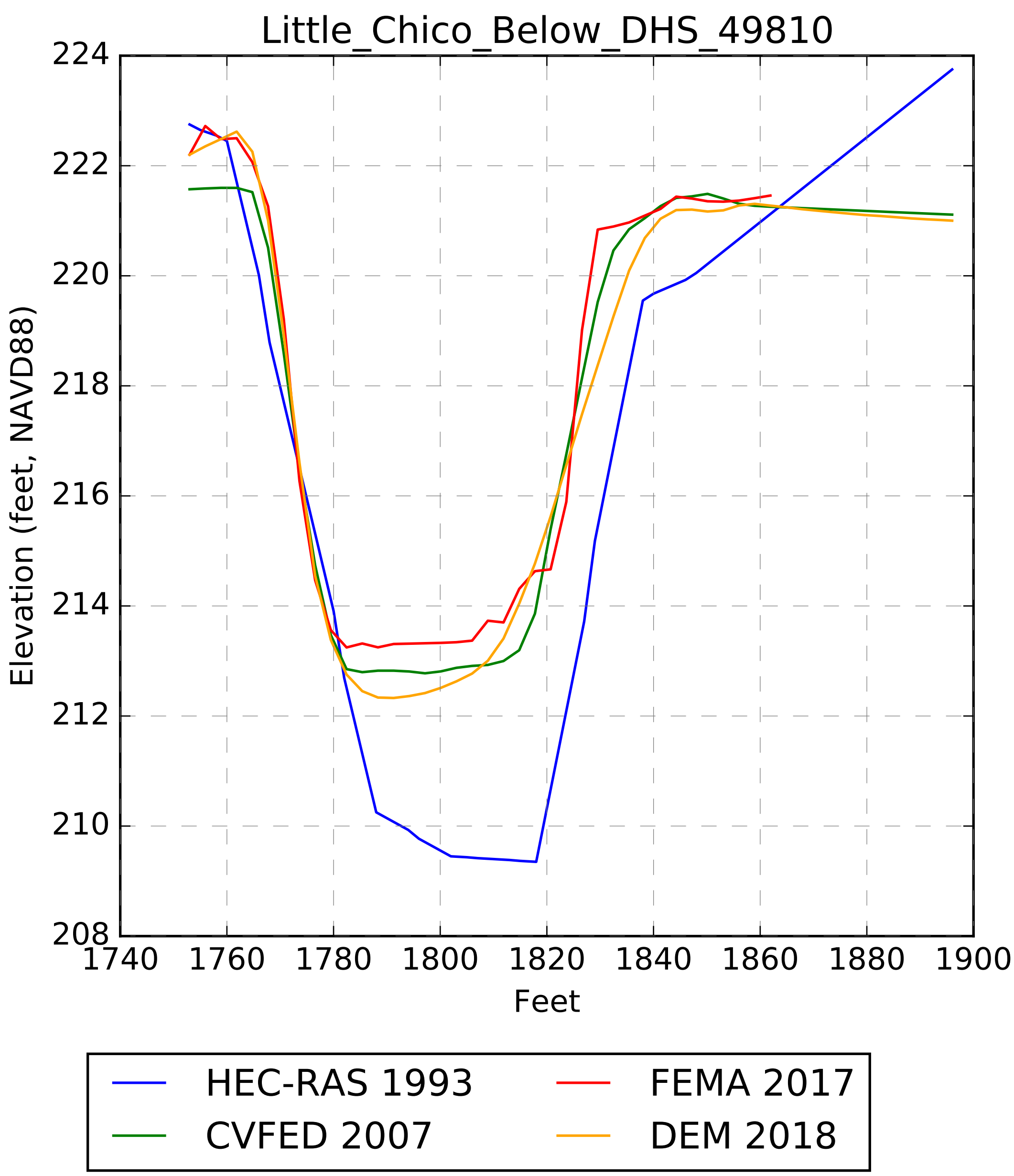

Little_Chico_Below_DHS_46215
208
206
204
202
200
198
196
194
192
1160
1180
1200
1220
1240
1260
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

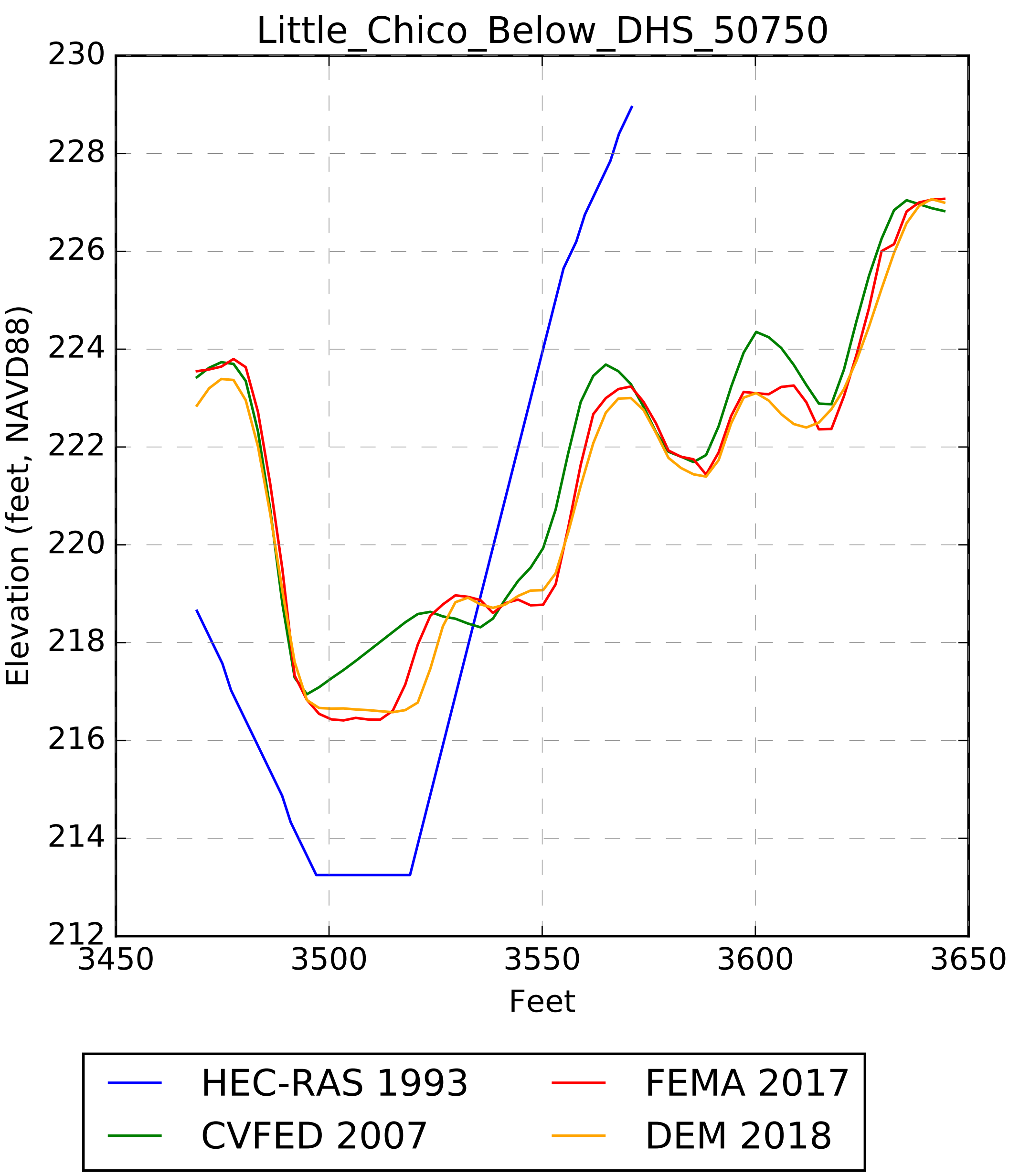

Little_Chico_Below_DHS_47900
Elevation (feet, NAVD88)
Feet
216
214
212
210
208
206
204
202
200
2240
2260
2280
2300
2320
2340
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018

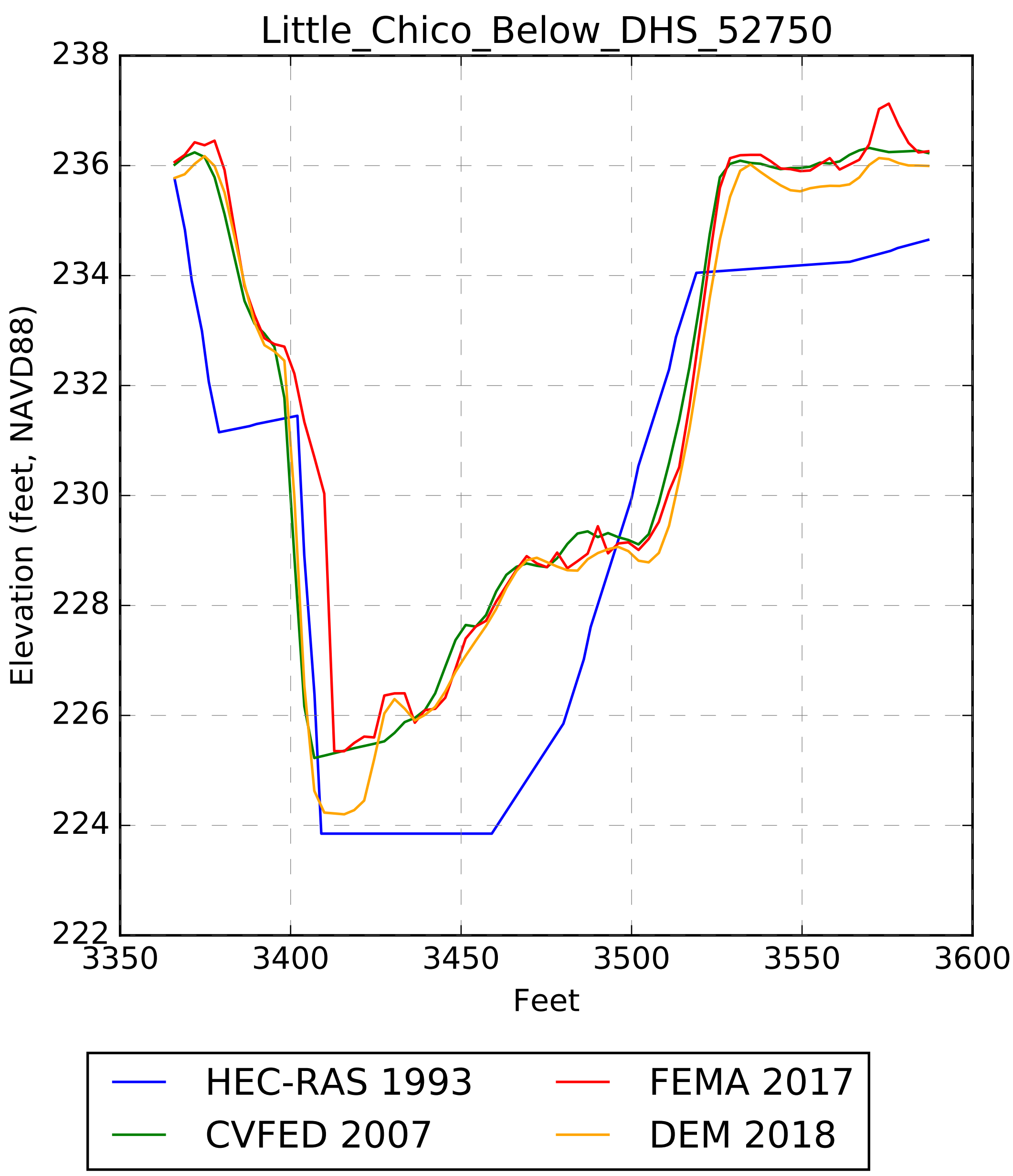

Little_Chico_Below_DHS_48679
Elevation (feet, NAVD88)
Feet
220
215
210
205
200
195
2800
2820
2840
2860
2880
2900
2920
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018



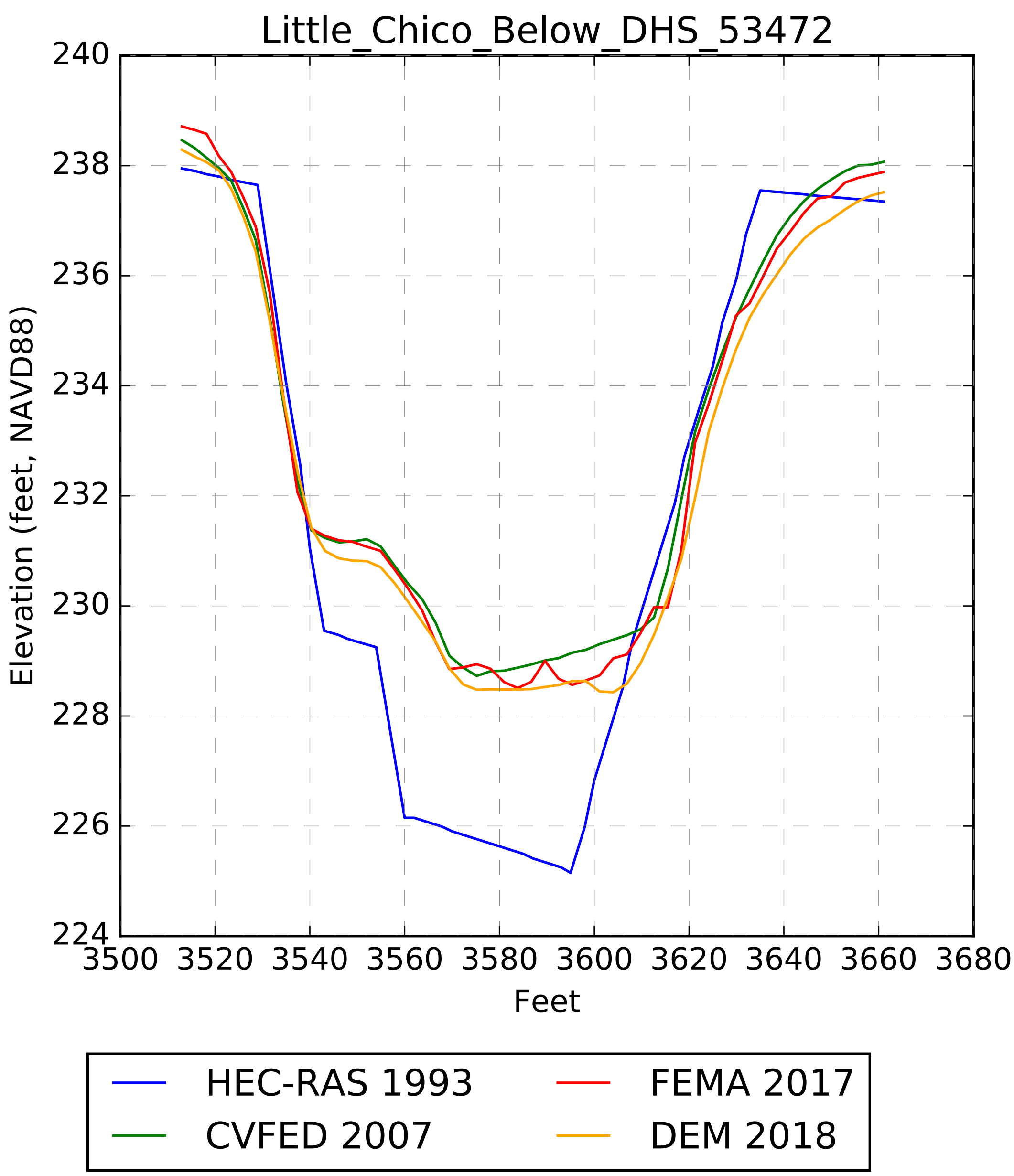
Little_Chico_Below_DHS_48726
220
215
210
205
200
195
2820
2830
2840
2850
2860
2870
2880
2890
2900
2910
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

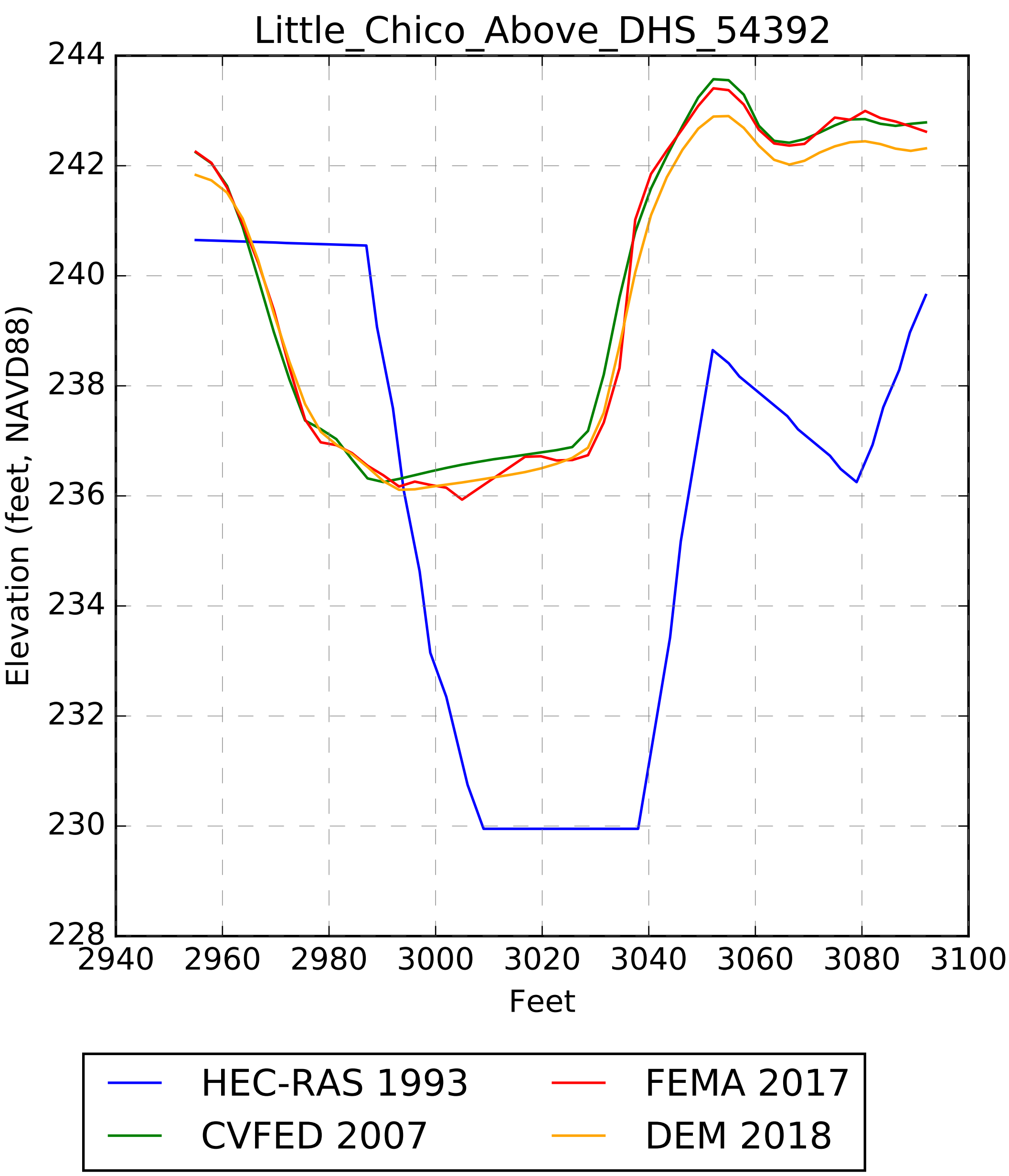

Little_Chico_Below_DHS_49810
Elevation (feet, NAVD88)
Feet
224
222
220
218
216
214
212
210
208
1740
1760
1780
1800
1820
1840
1860
1880
1900
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018


Little_Chico_Below_DHS_50750
Elevation (feet, NAVD88)
Feet
230
228
226
224
222
220
218
216
214
212
3450
3500
3550
3600
3650
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

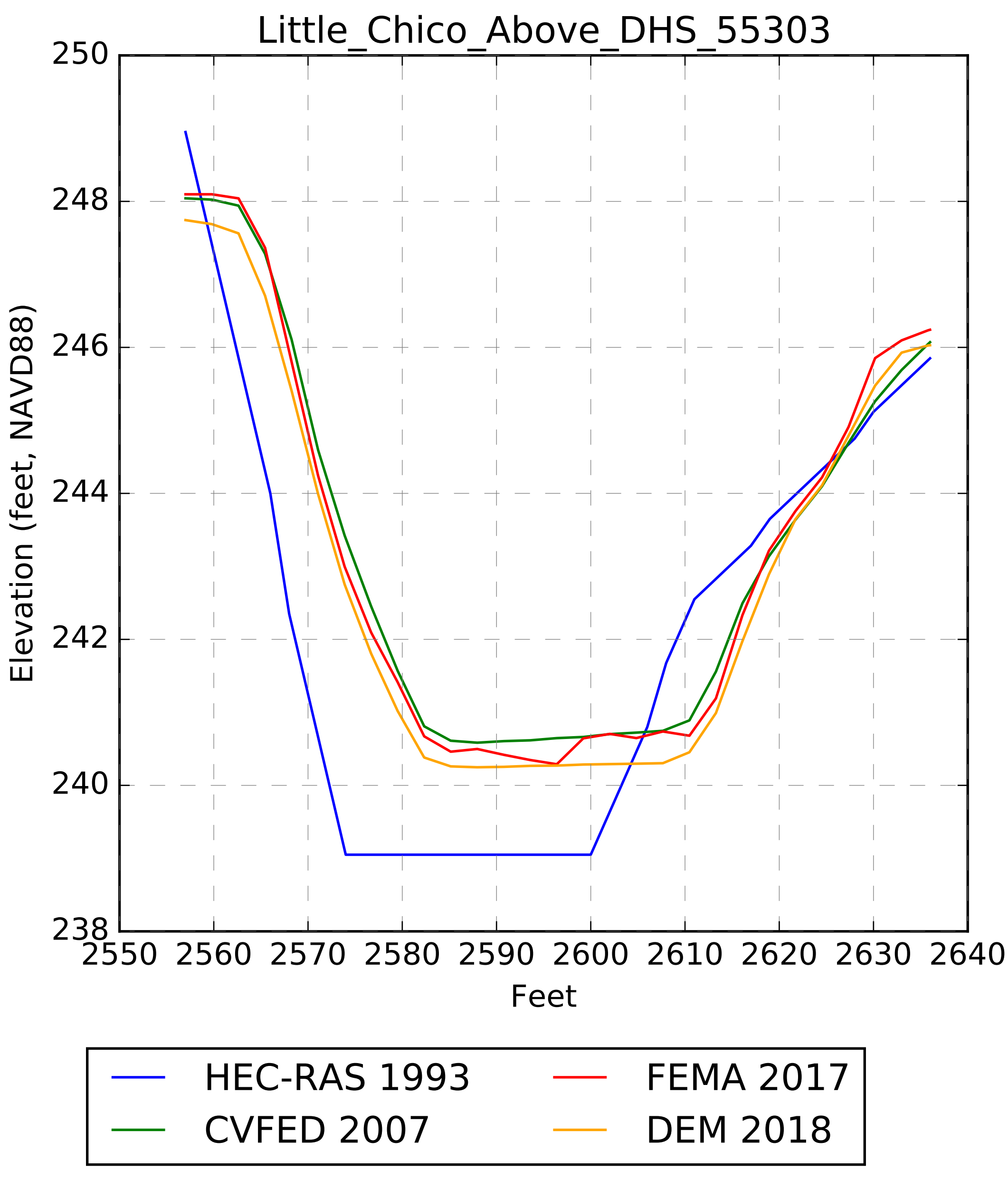


Little_Chico_Below_DHS_52750
238
236
234
232
230
228
226
224
222
3350
3400
3450
3500
3550
3600
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018

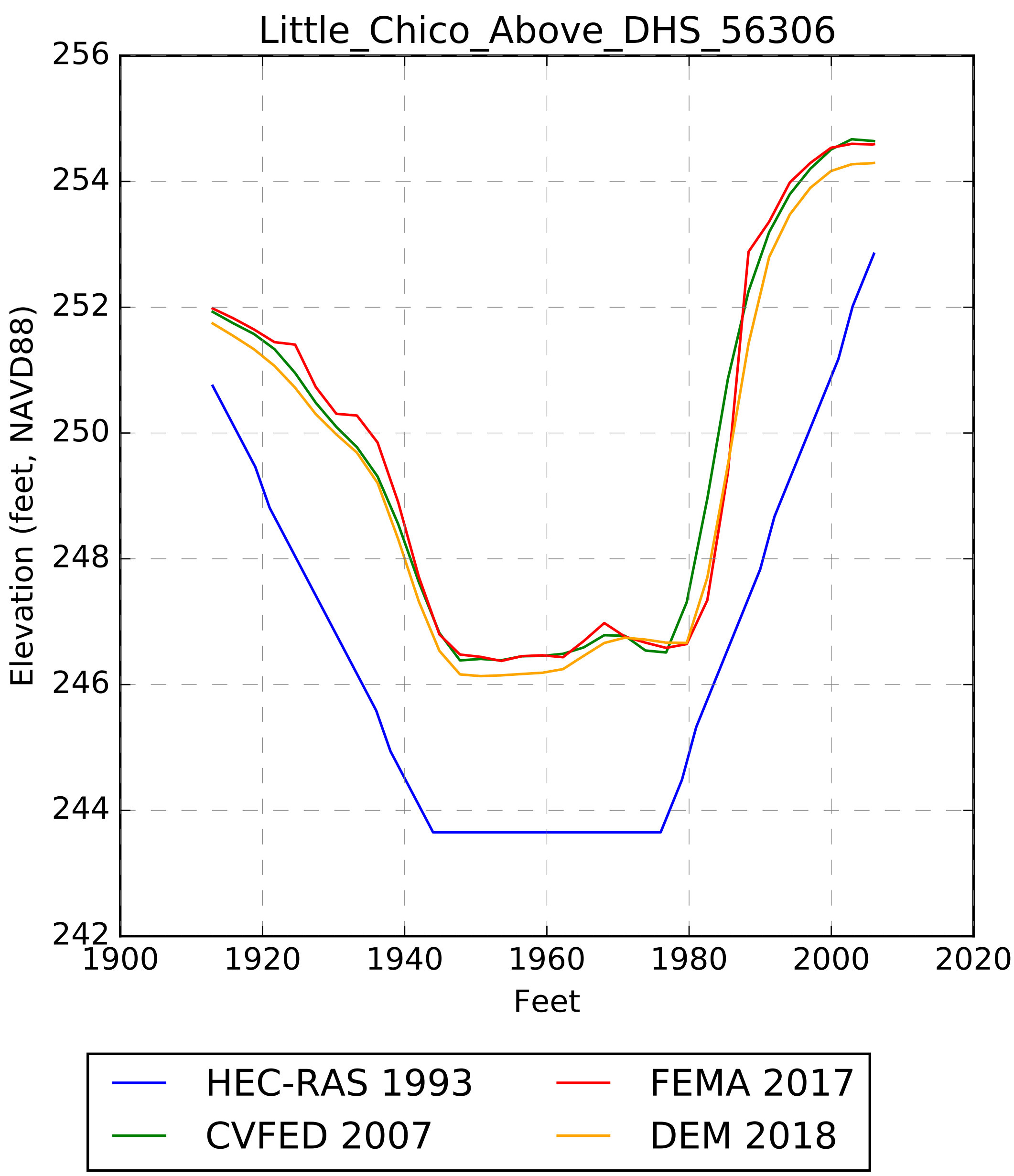

Little_Chico_Below_DHS_53472
Elevation (feet, NAVD88)
Feet
240
238
236
234
232
230
228
226
224
3500
3520
3540
3560
3580
3600
3620
3640
3660
3680
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

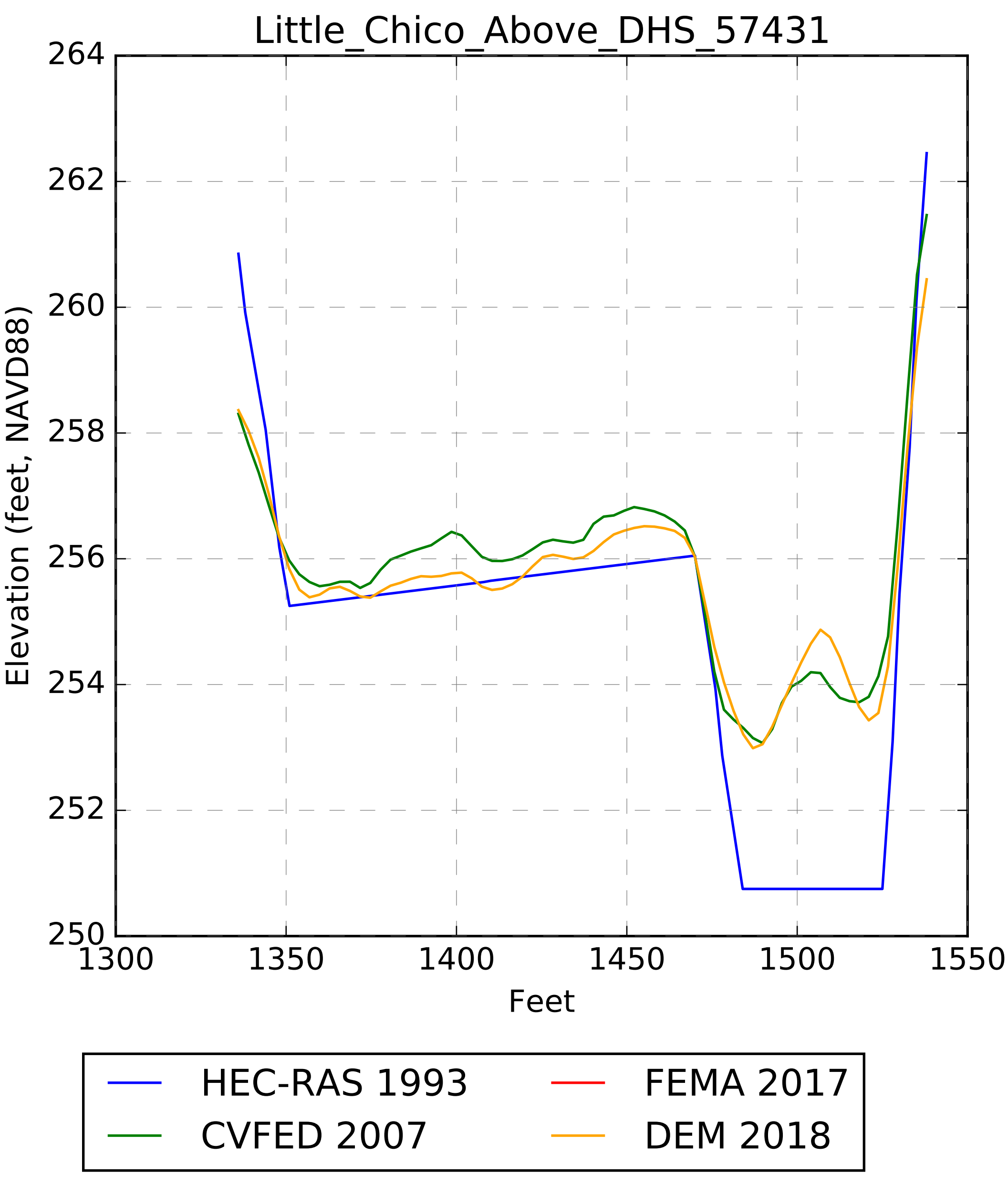


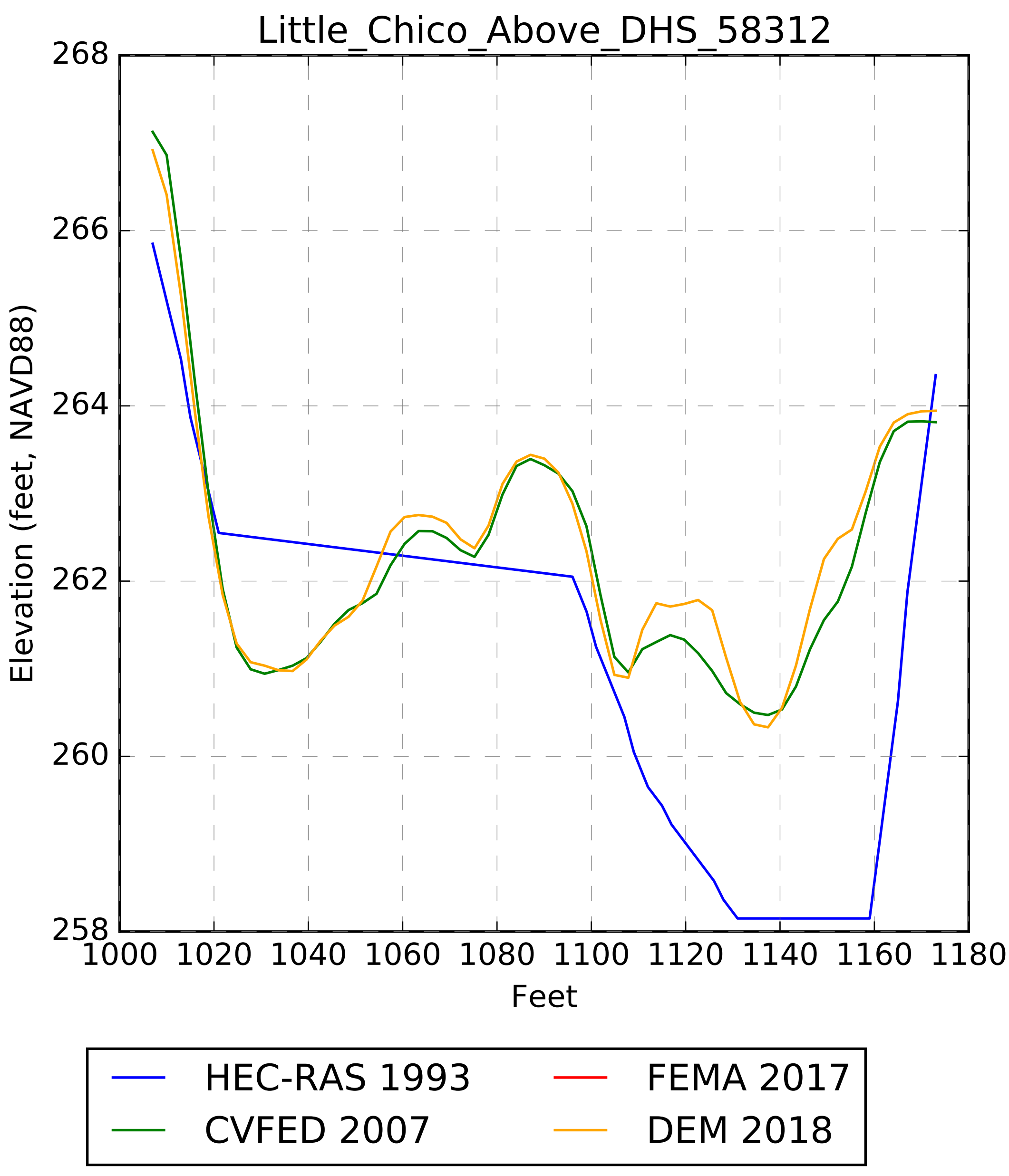
Little_Chico_Above_DHS_54392
Elevation (feet, NAVD88)
Feet
244
242
240
238
236
234
232
230
228
2940
2960
2980
3000
3020
3040
3060
3080
3100
HEC-RAS 1993
CVFED 2007
FEMA 2017
DEM 2018

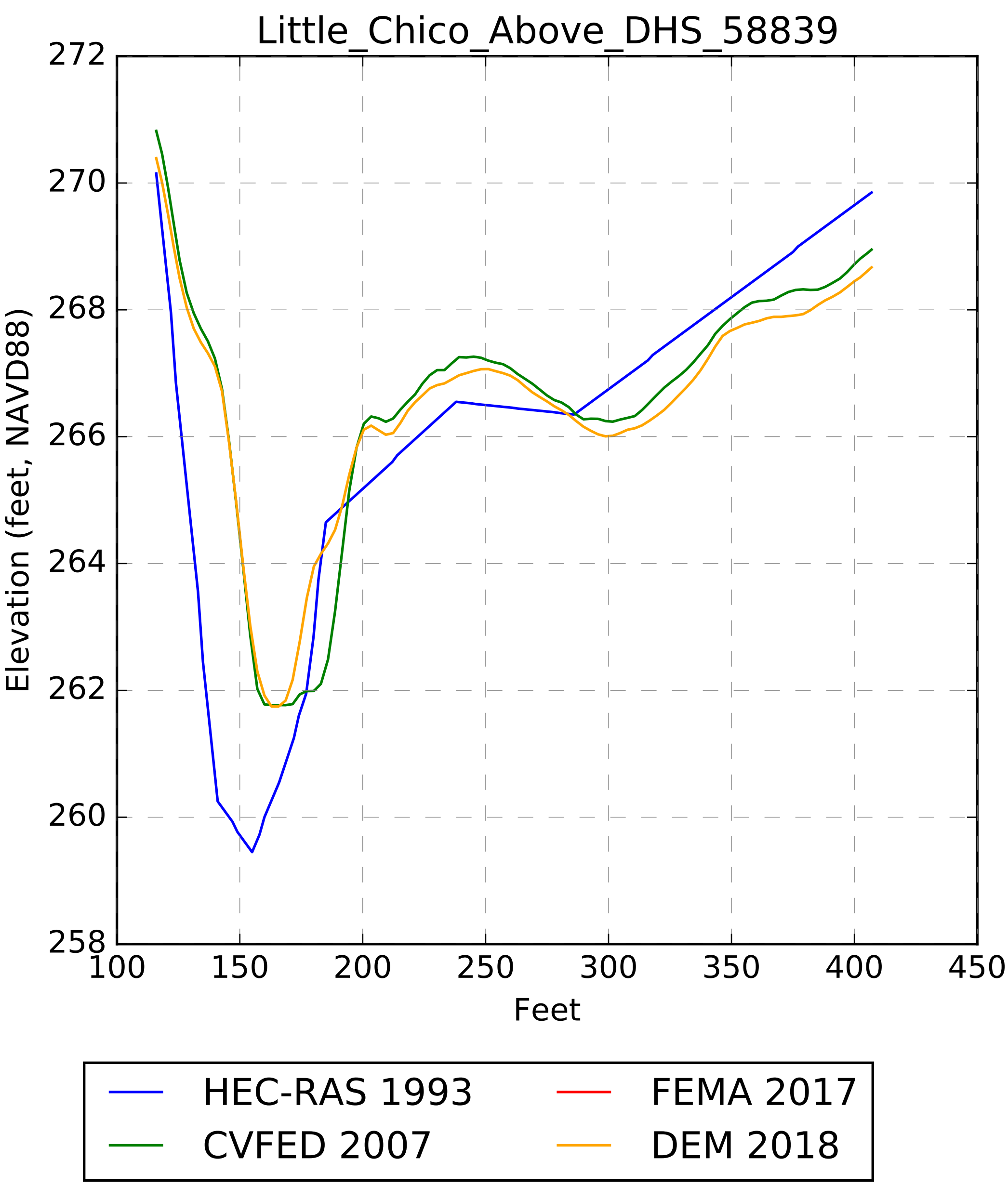


Little_Chico_Above_DHS_55303
250
248
246
244
242
240
238
2550
2560
2570
2580
2590
2600
2610
2620
2630
2640
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

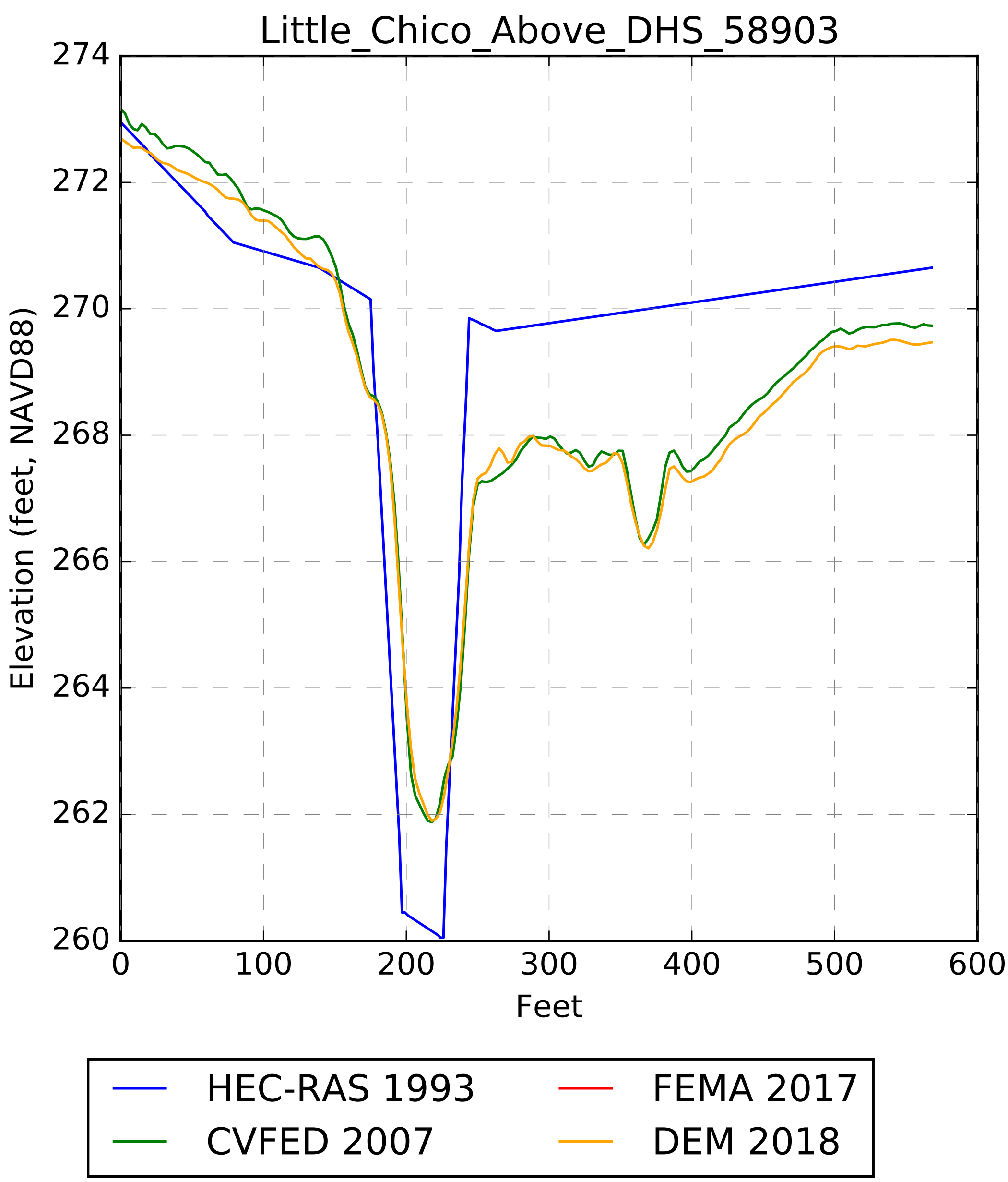

Little_Chico_Above_DHS_56306
Elevation (feet, NAVD88)
Feet
256
254
252
250
248
246
244
242
1900
1920
1940
1960
1980
2000
2020
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018


Little_Chico_Above_DHS_57431
264
262
260
258
256
254
252
250
1300
1350
1400
1450
1500
1550
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018


Little_Chico_Above_DHS_58312
Elevation (feet, NAVD88)
Feet
268
266
264
262
260
258
1000
1020
1040
1060
1080
1100
1120
1140
1160
1180
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018



Little_Chico_Above_DHS_58839
Elevation (feet, NAVD88)
Feet
272
270
268
266
264
262
260
258
100
150
200
250
300
350
400
450
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018



Little_Chico_Above_DHS_58903
Elevation (feet, NAVD88)
Feet
274
272
270
268
266
264
262
260
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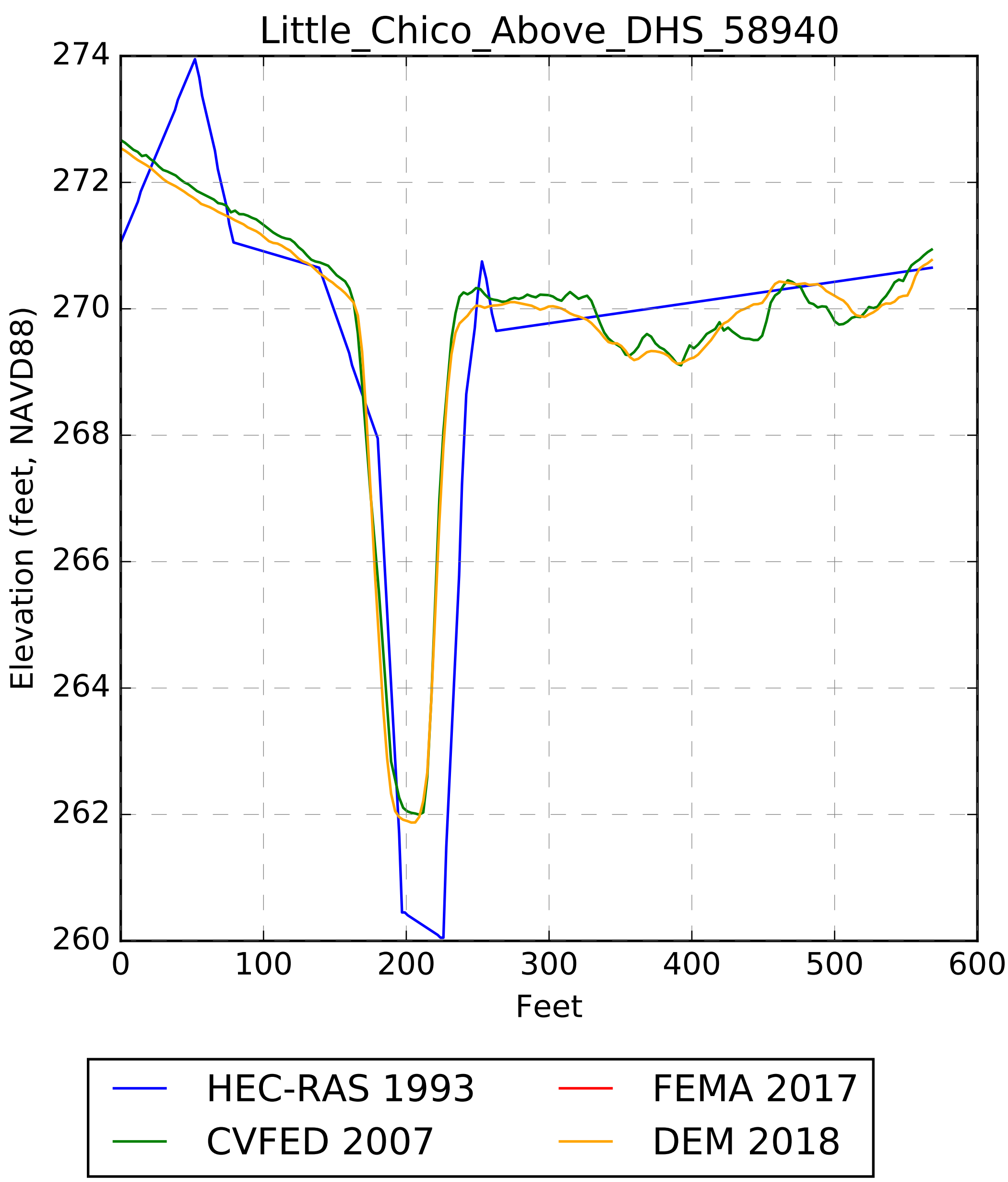
100
200
300
400
500
600
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018



Little_Chico_Above_DHS_58940
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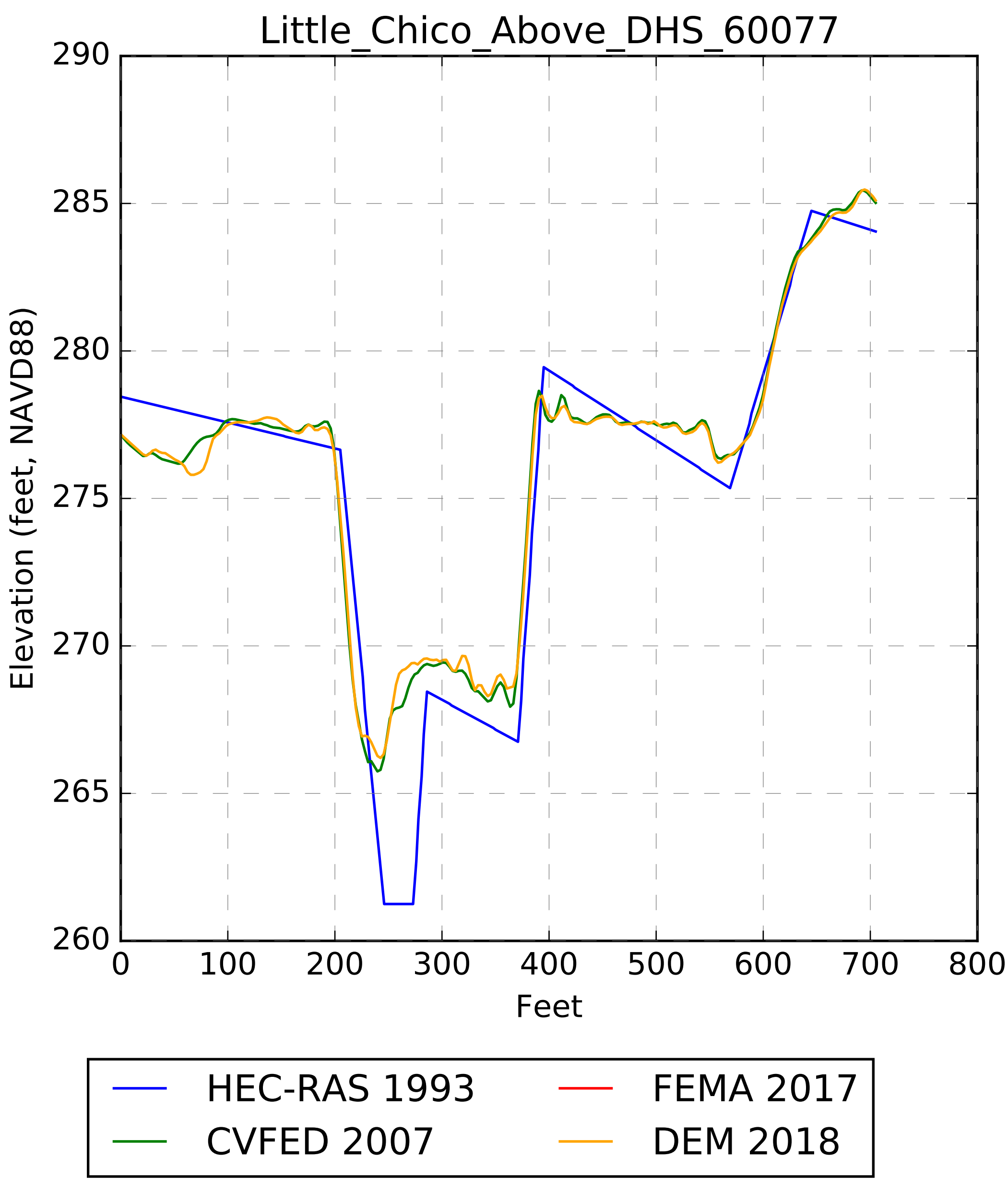
272
270
268
266
264
262
260
0
100
200
300
400
500
600
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018



Little_Chico_Above_DHS_60077
Elevation (feet, NAVD88)
Feet
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285
280
275
270
265
260
0
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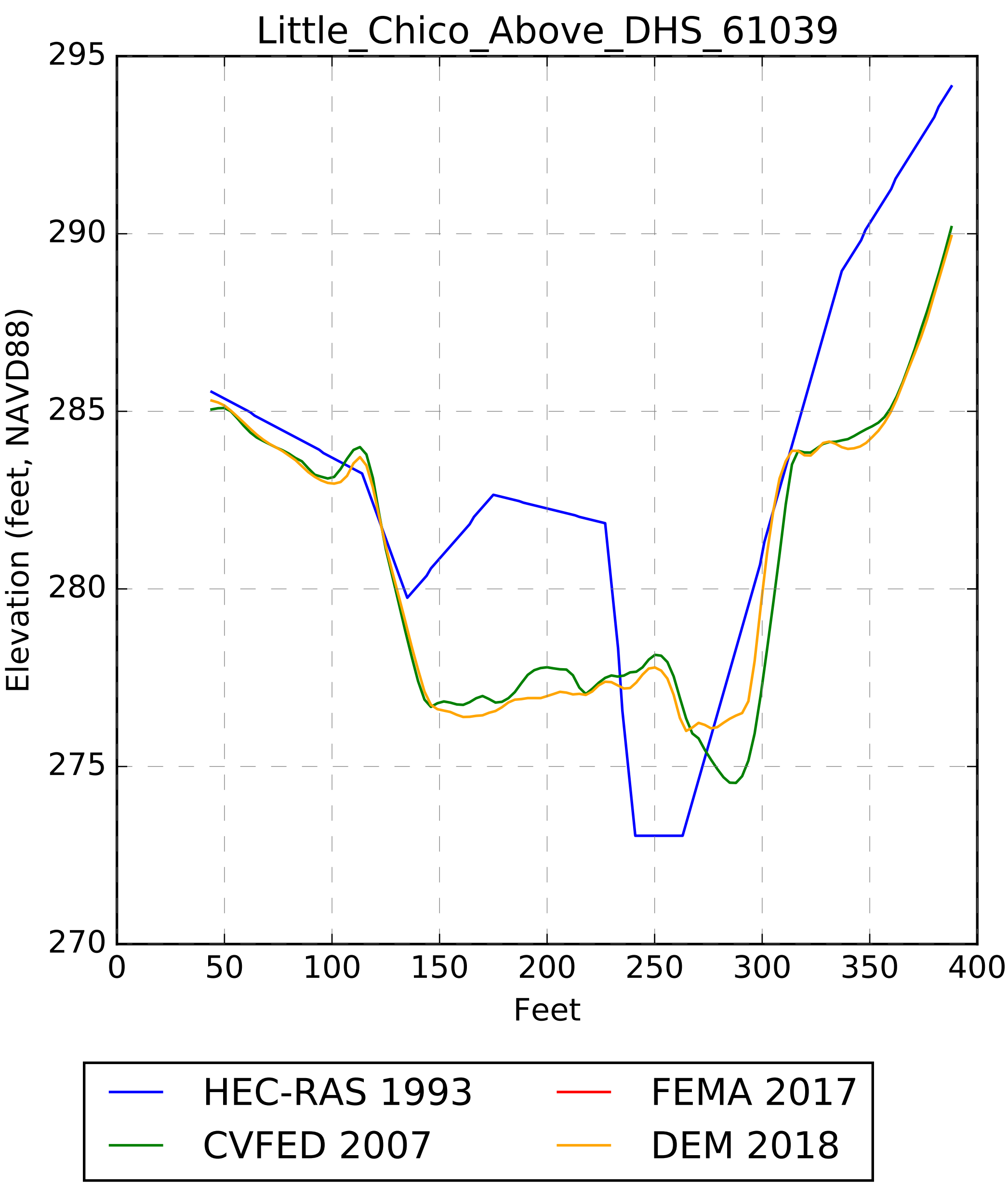
200
300
400
500
600
700
800
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018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295
290
285
280
275
270
0
50
100
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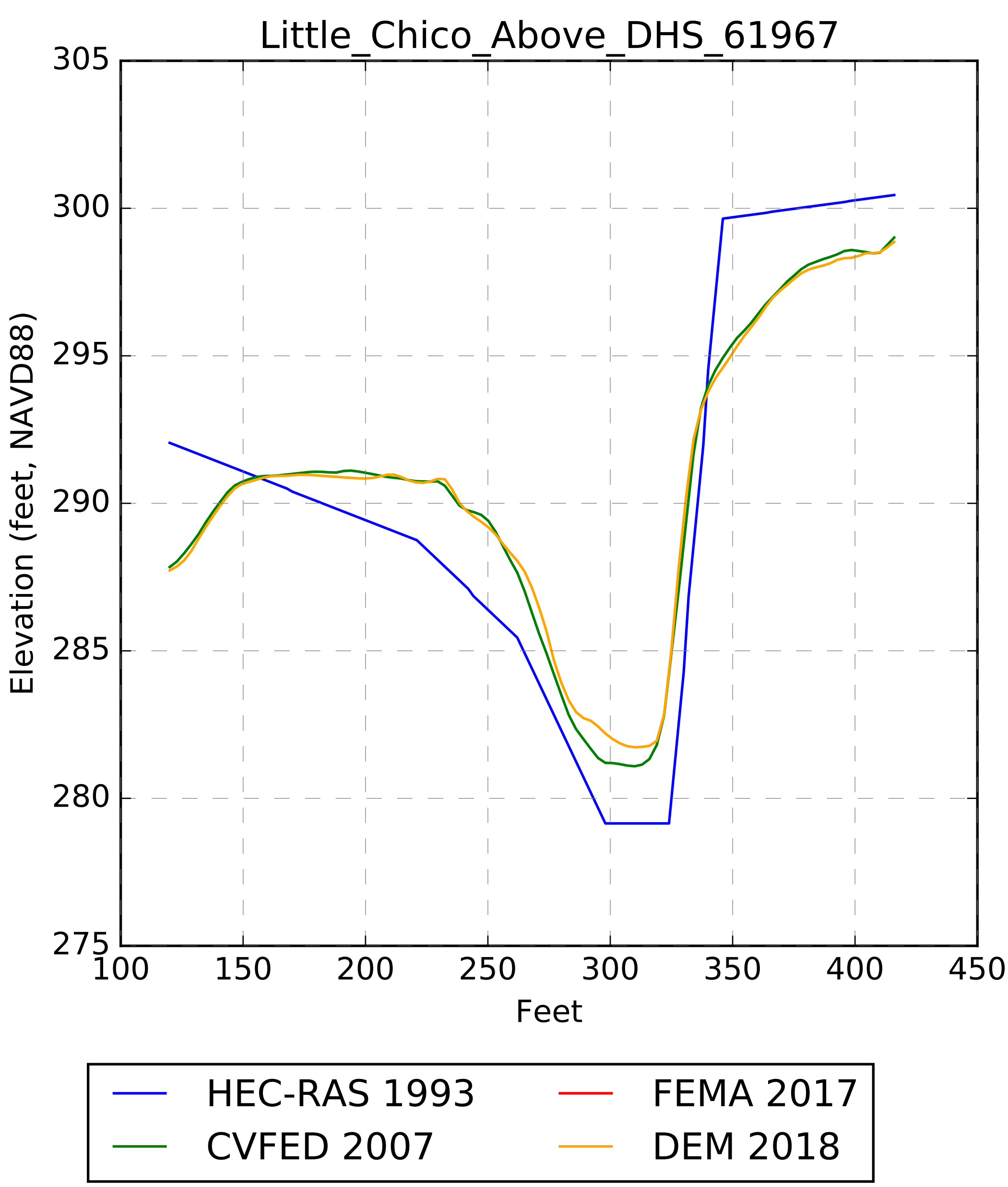
250
300
350
400
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018



Little_Chico_Above_DHS_61967
305
300
295
290
285
280
275
Elevation (feet, NAVD88)
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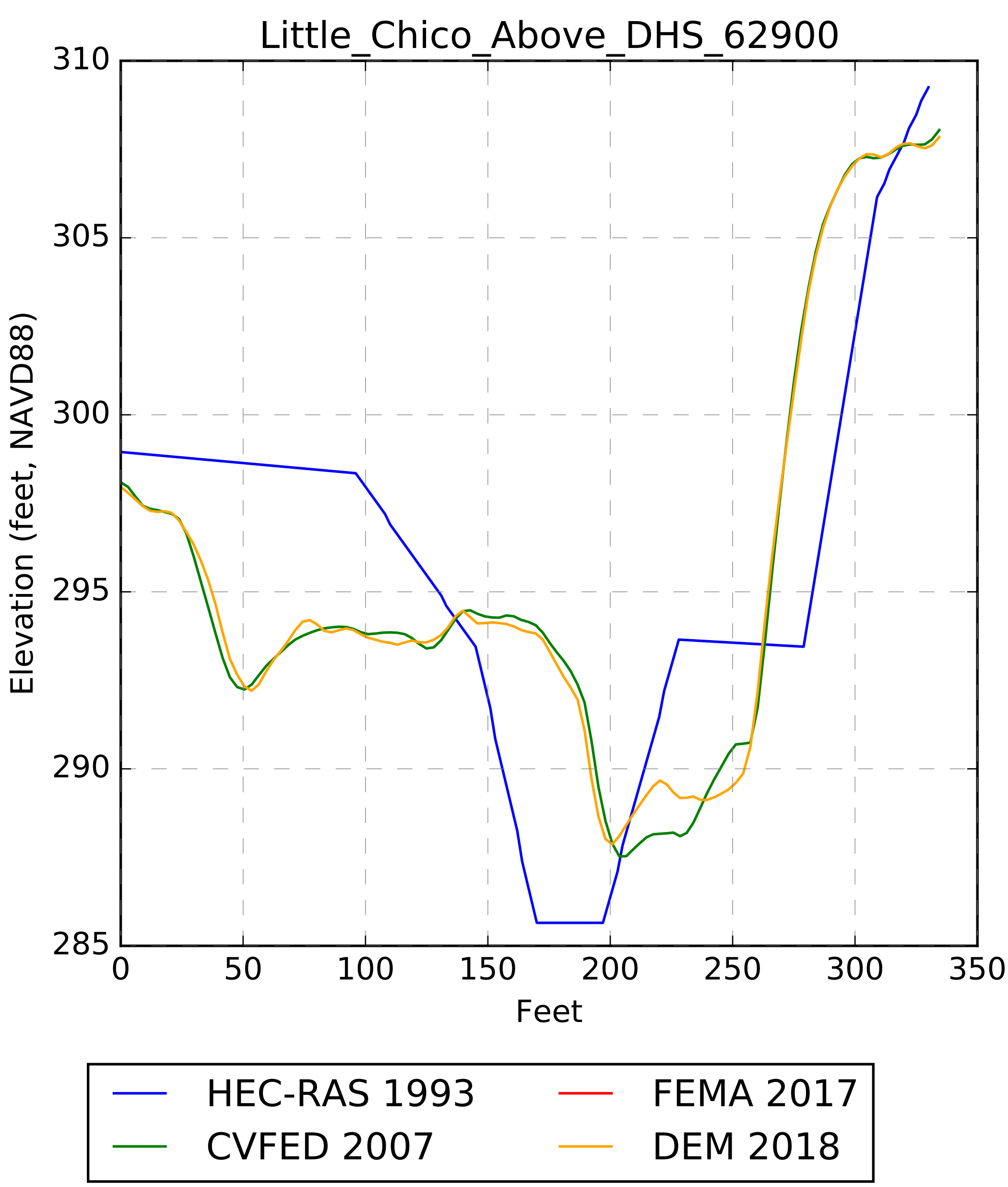
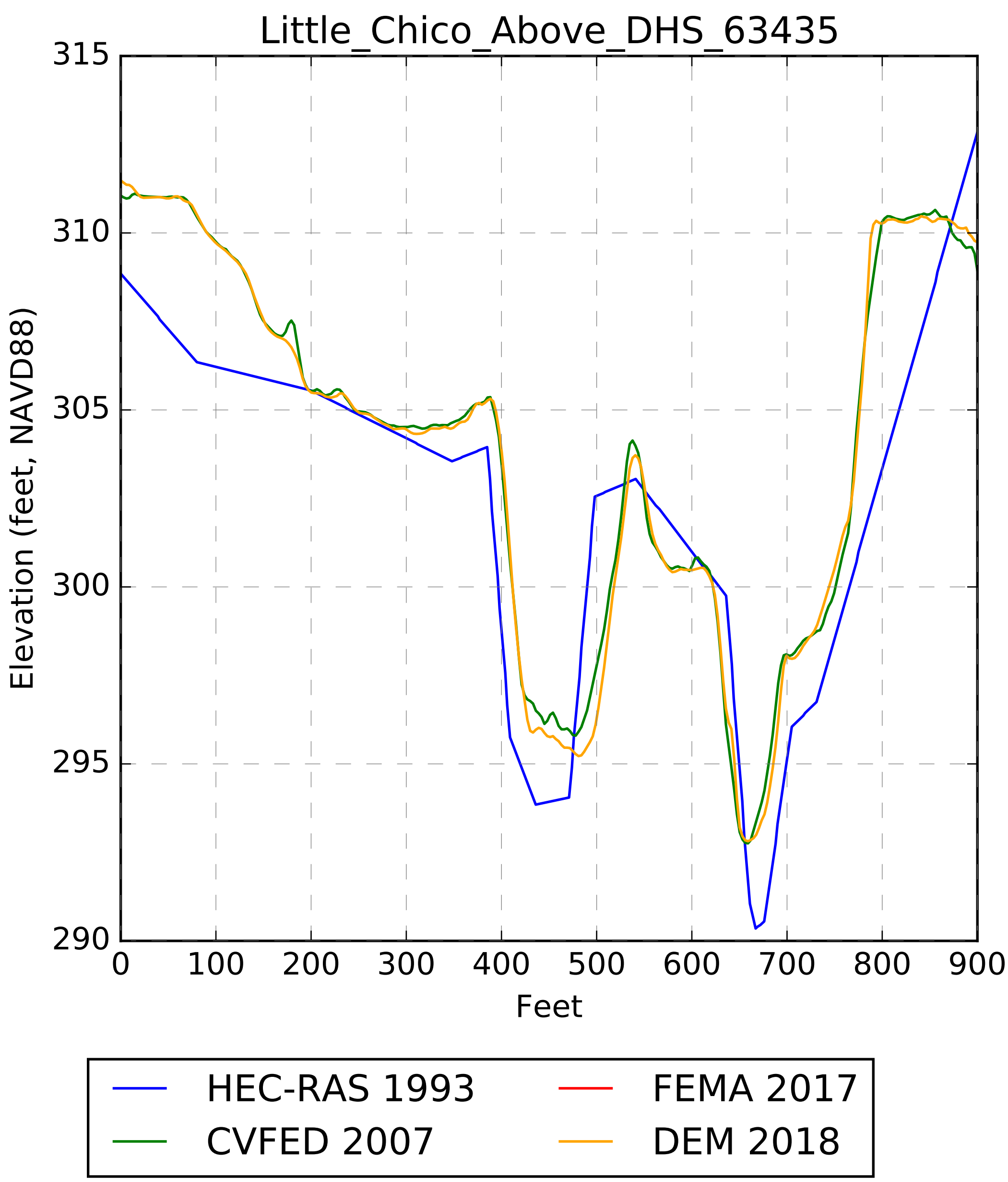
150
200
250
300
350
400
450
Feet
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018



Little_Chico_Above_DHS_62900
310
305
300
295
290
285
0
50
100
150
200
250
300
350
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018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295
290
0
100
200
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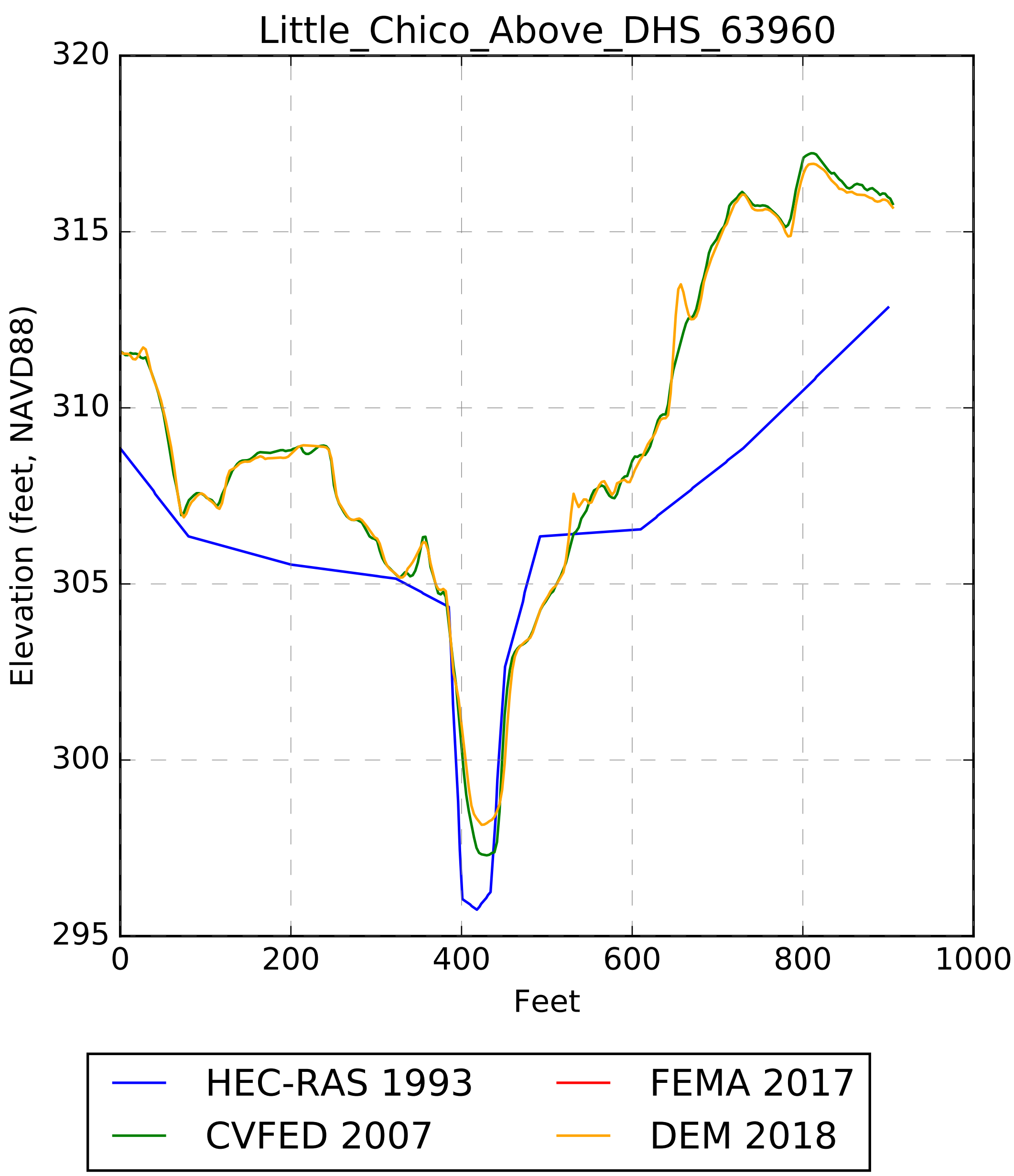
700
800
900
Feet
Elevation (feet, NAVD88)
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

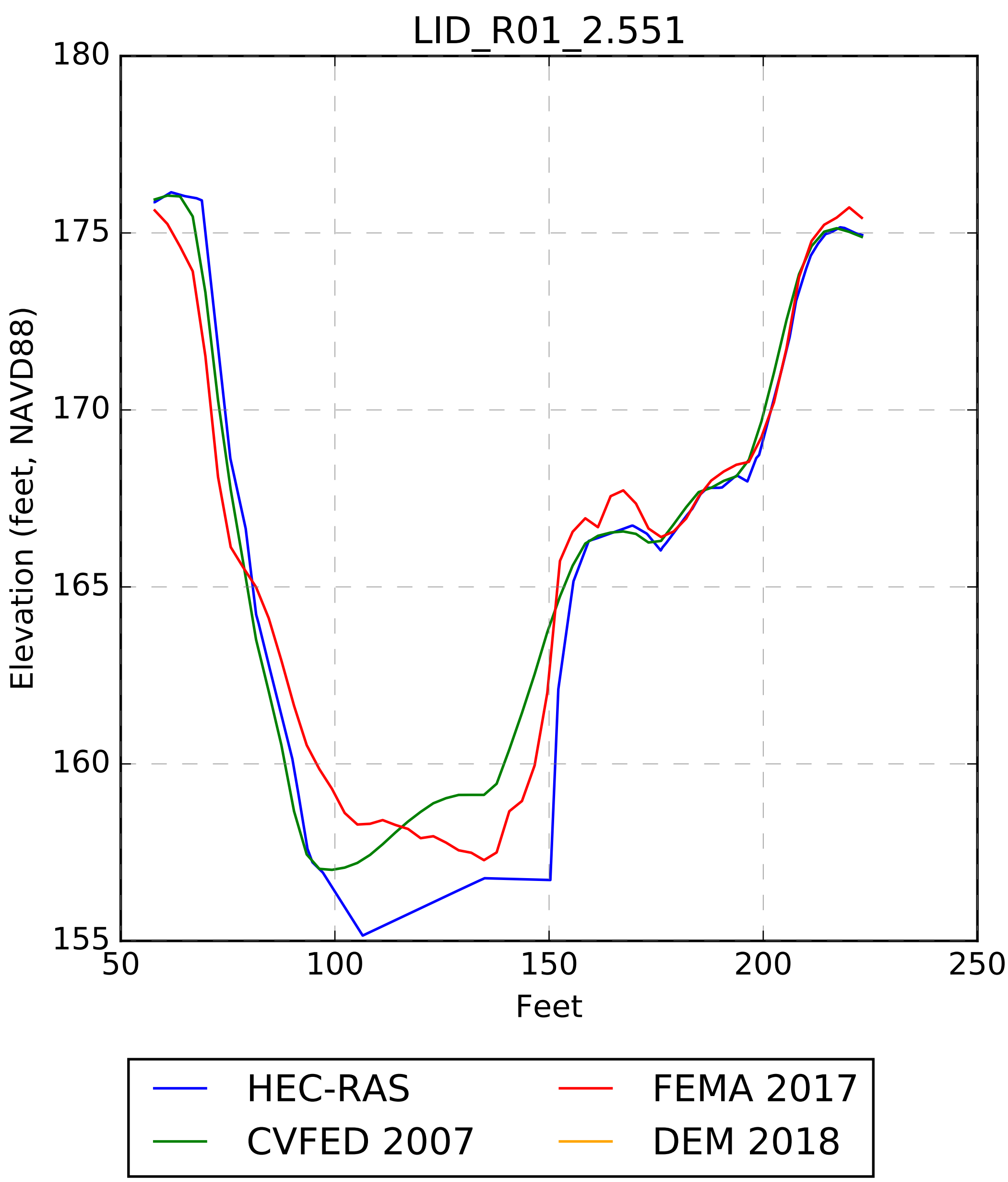


Little_Chico_Above_DHS_63960
Elevation (feet, NAVD88)
320
315
310
305
300
295
0
200
400
600
800
1000
Feet
HEC-RAS 1993
FEMA 2017
CVFED 2007
DEM 2018

City of Chico

Storm Water Master Plan

Appendix F.3 – Lindo Channel Cross Section Comparisons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Elevation (feet, NAVD88)
Feet
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170
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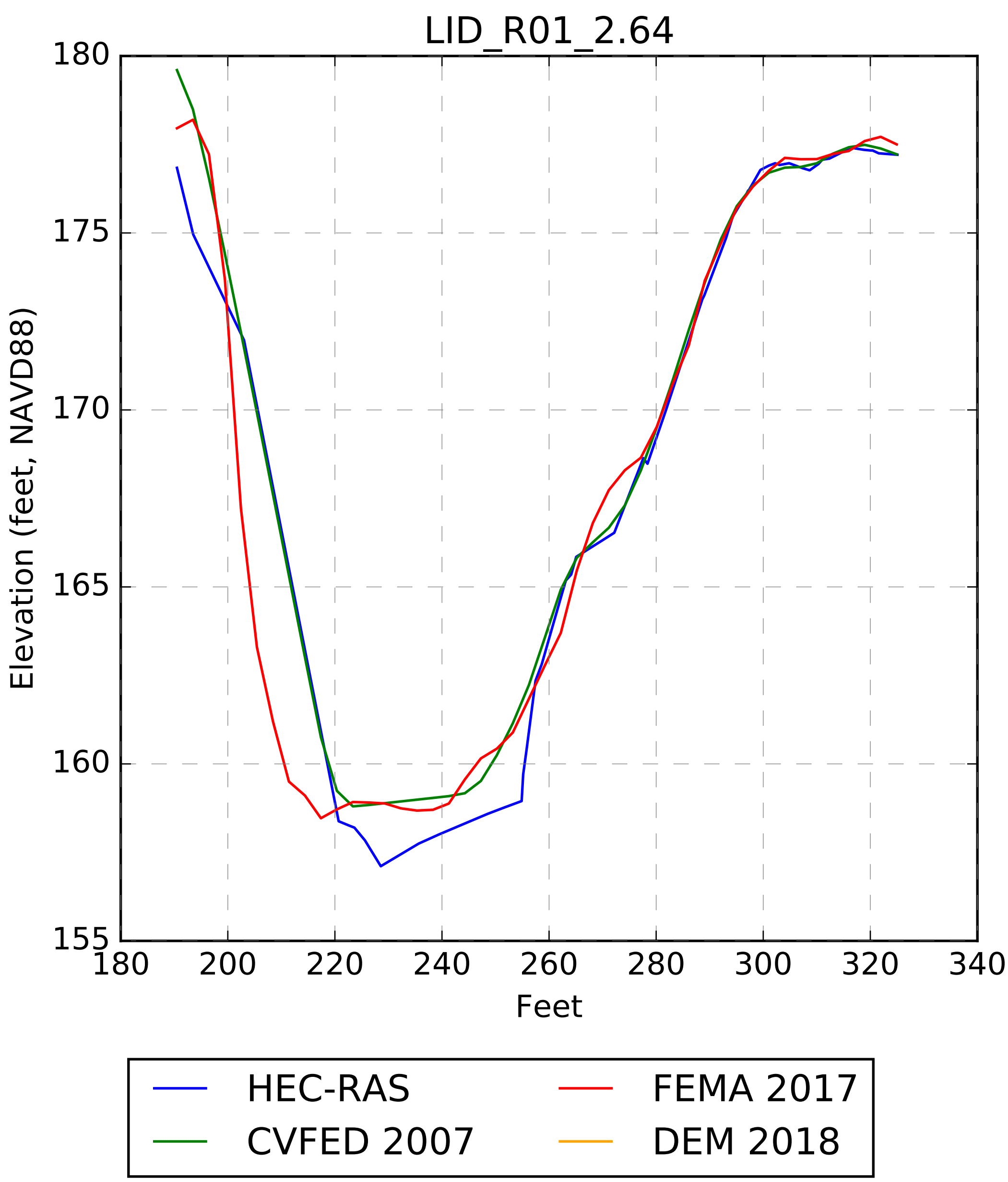
155
50
100
150
200
250
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018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Elevation (feet, NAVD88)
Feet
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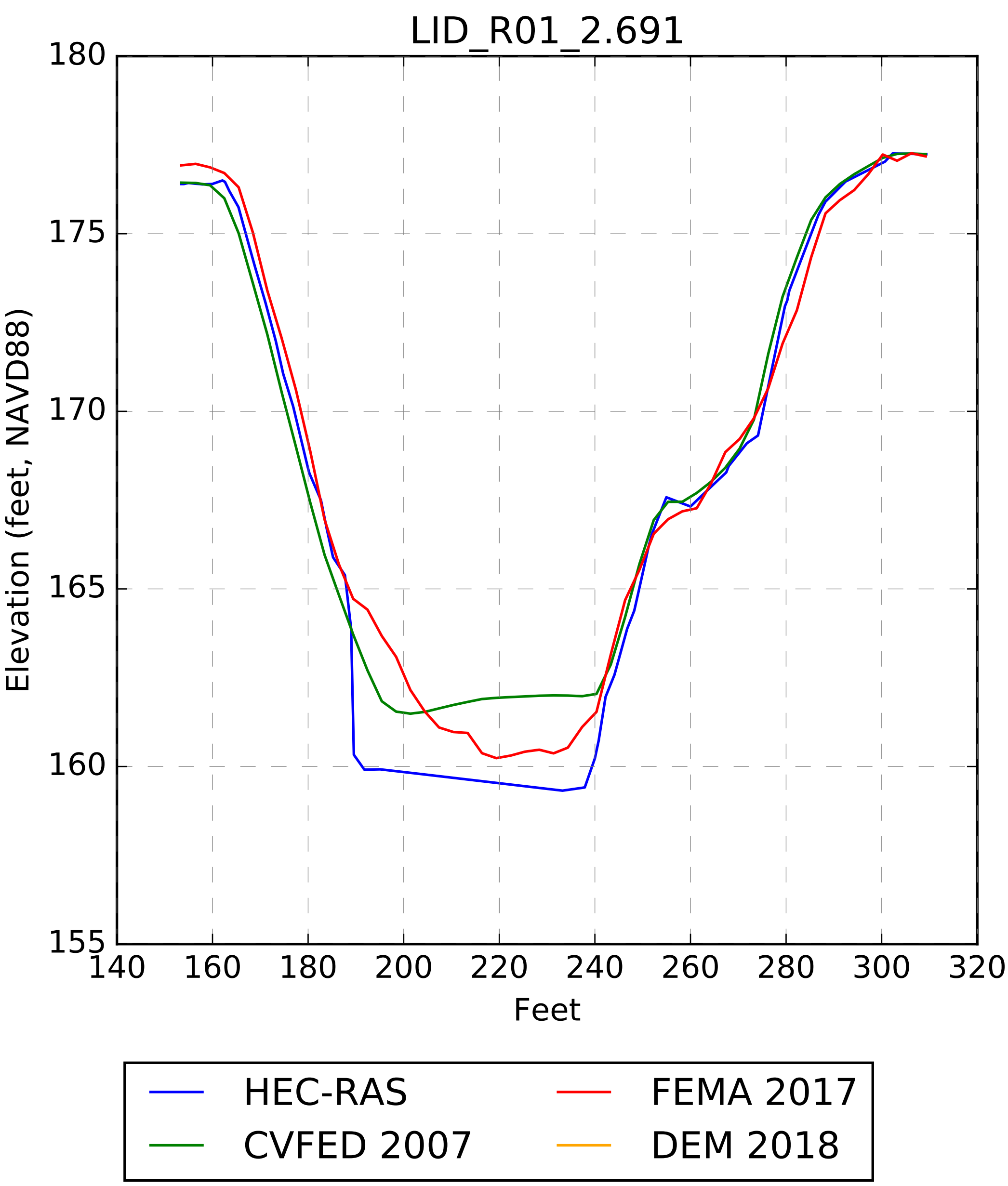
300
320
340
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018



LID_R01_2.691
Elevation (feet, NAVD88)
Feet
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175
170
165
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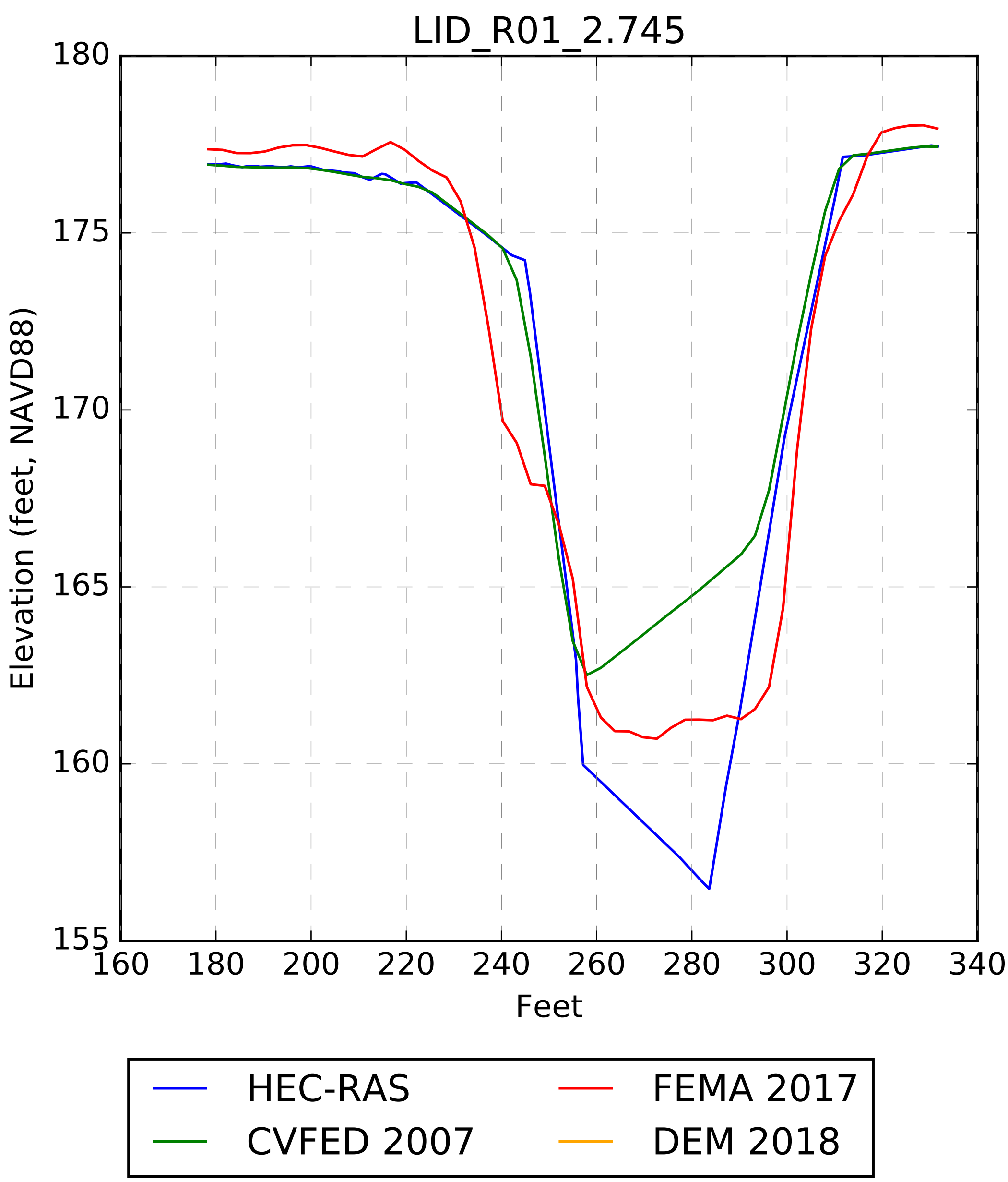
260
280
300
320
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018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180
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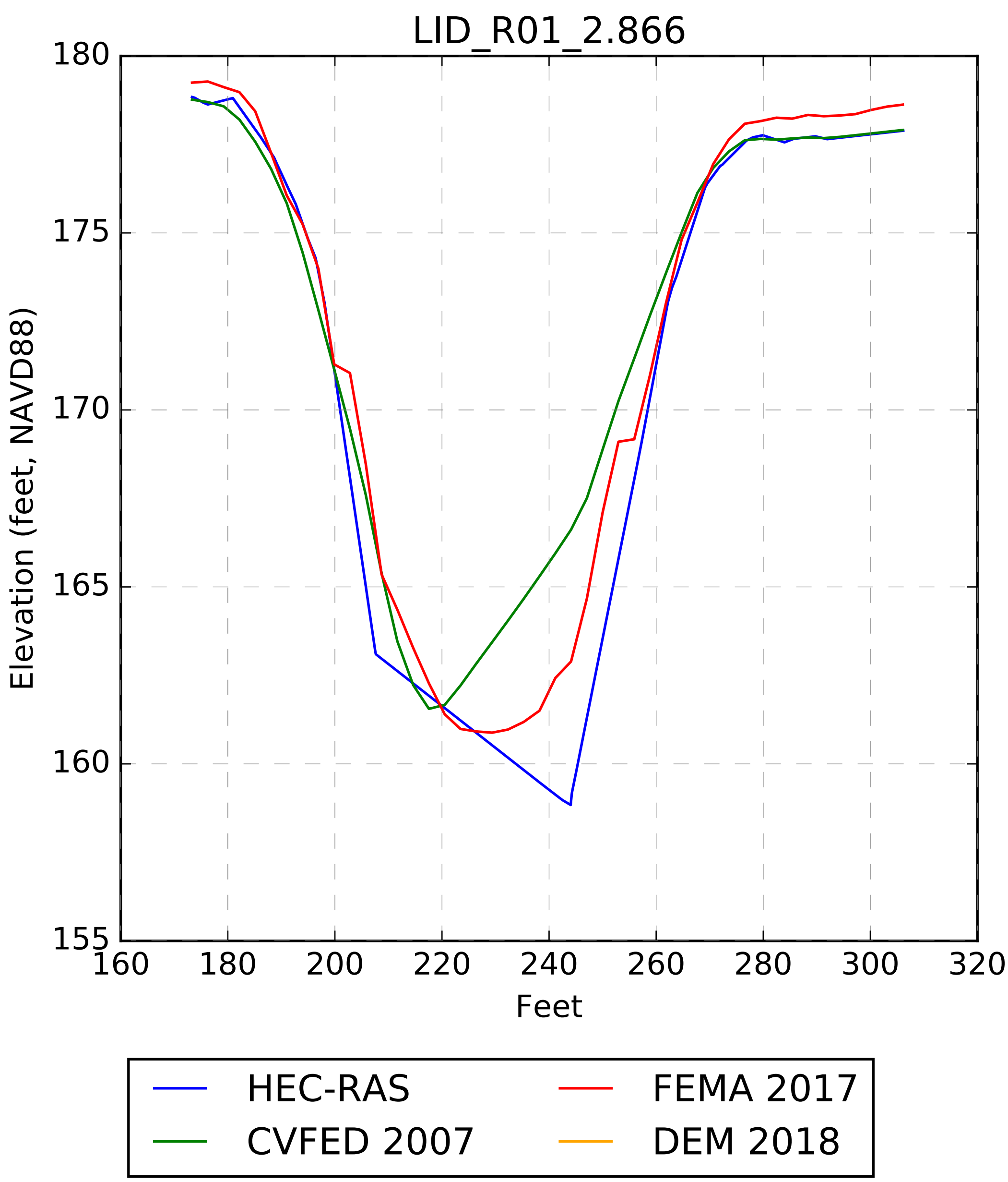
300
320
340
Feet
Elevation (feet, NAVD88)
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018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Elevation (feet, NAVD88)
Feet
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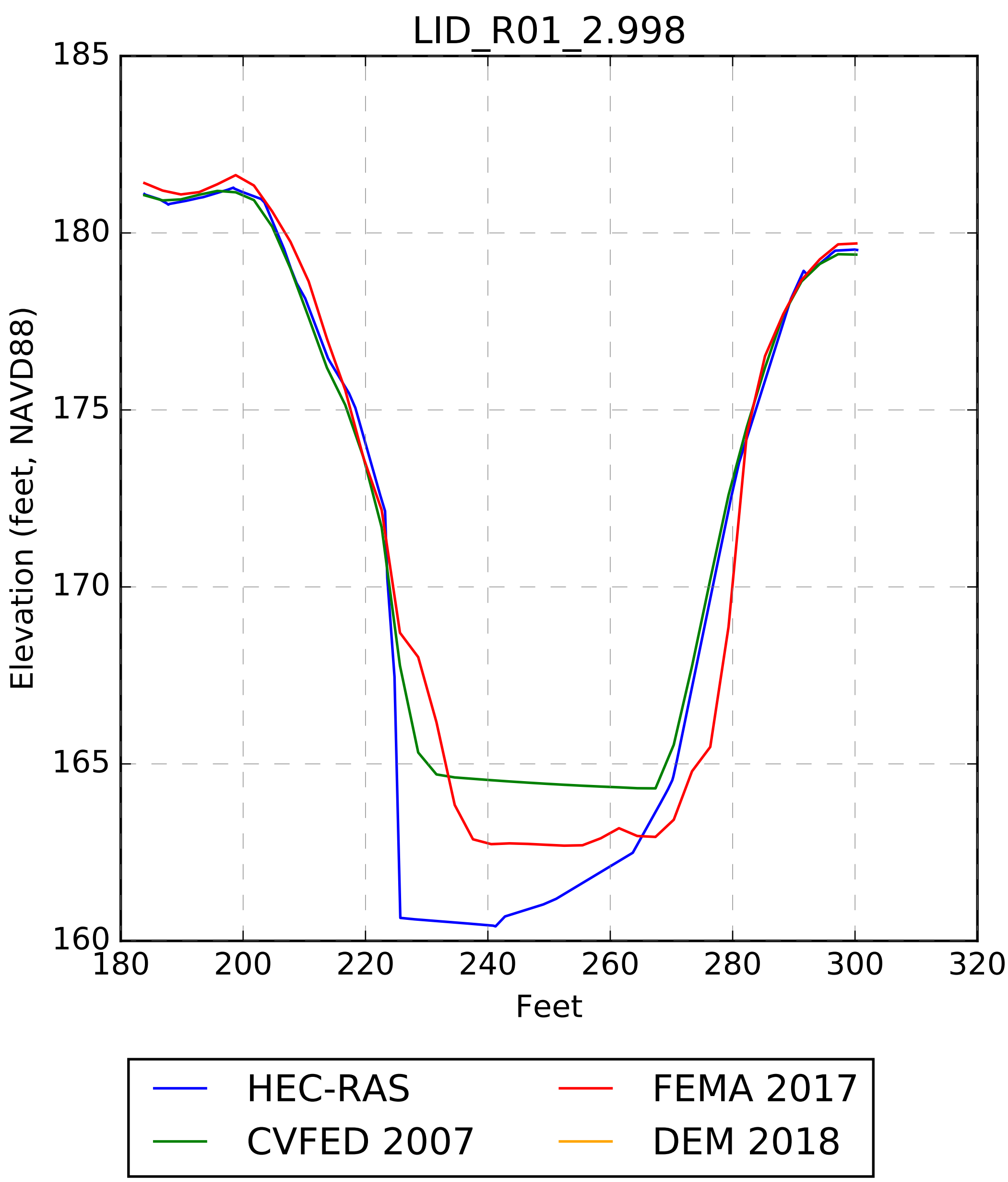
160
180
200
220
240
260
280
300
320
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018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170
165
160
180
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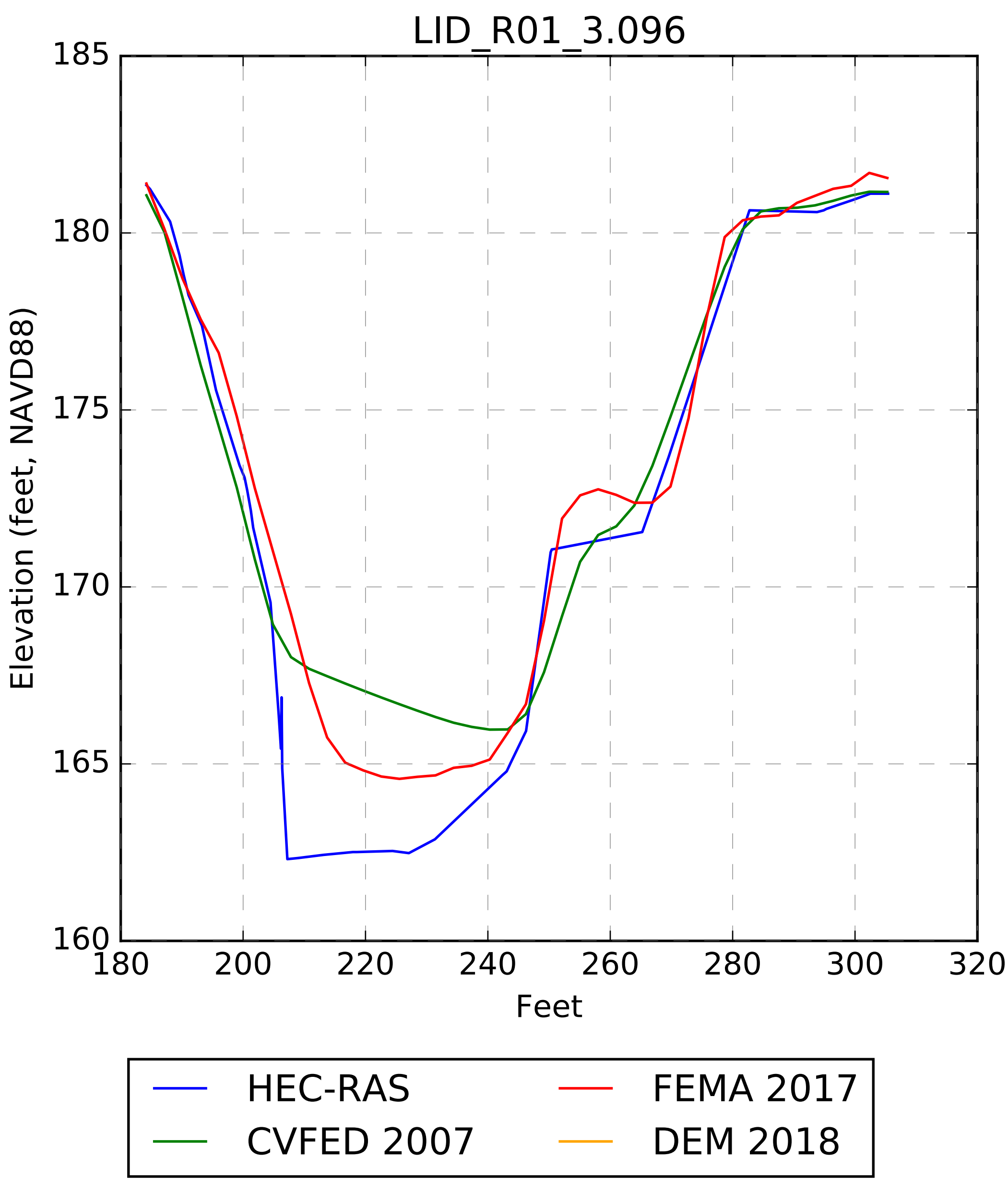
280
300
320
Feet
Elevation (feet, NAVD88)
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018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Elevation (feet, NAVD88)
Feet
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170
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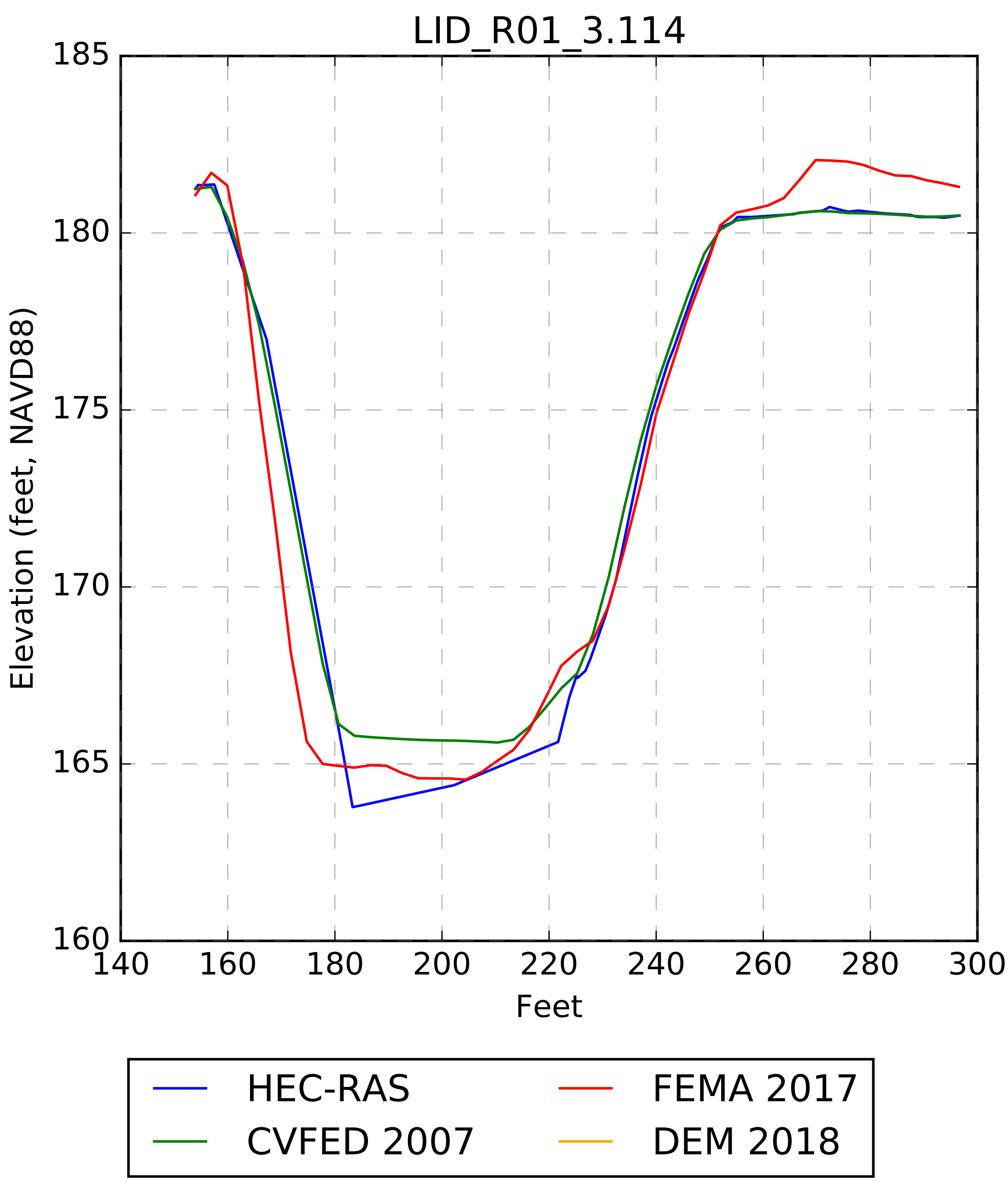
160
180
200
220
240
260
280
300
320
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



LID_R01_3.114
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170
165
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140
160
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200
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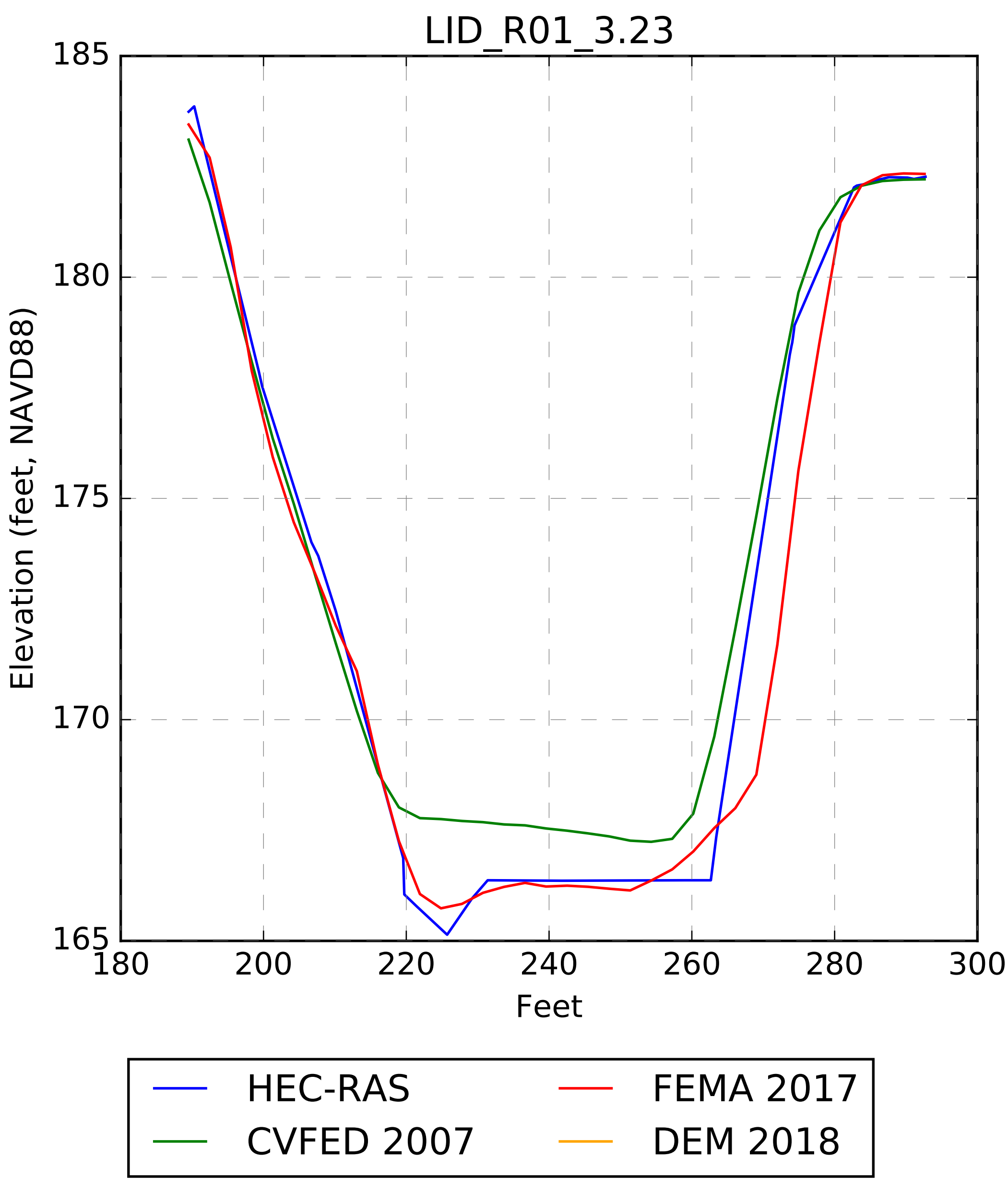
240
260
280
300
Feet
Elevation (feet, NAVD88)
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



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Elevation (feet, NAVD88)
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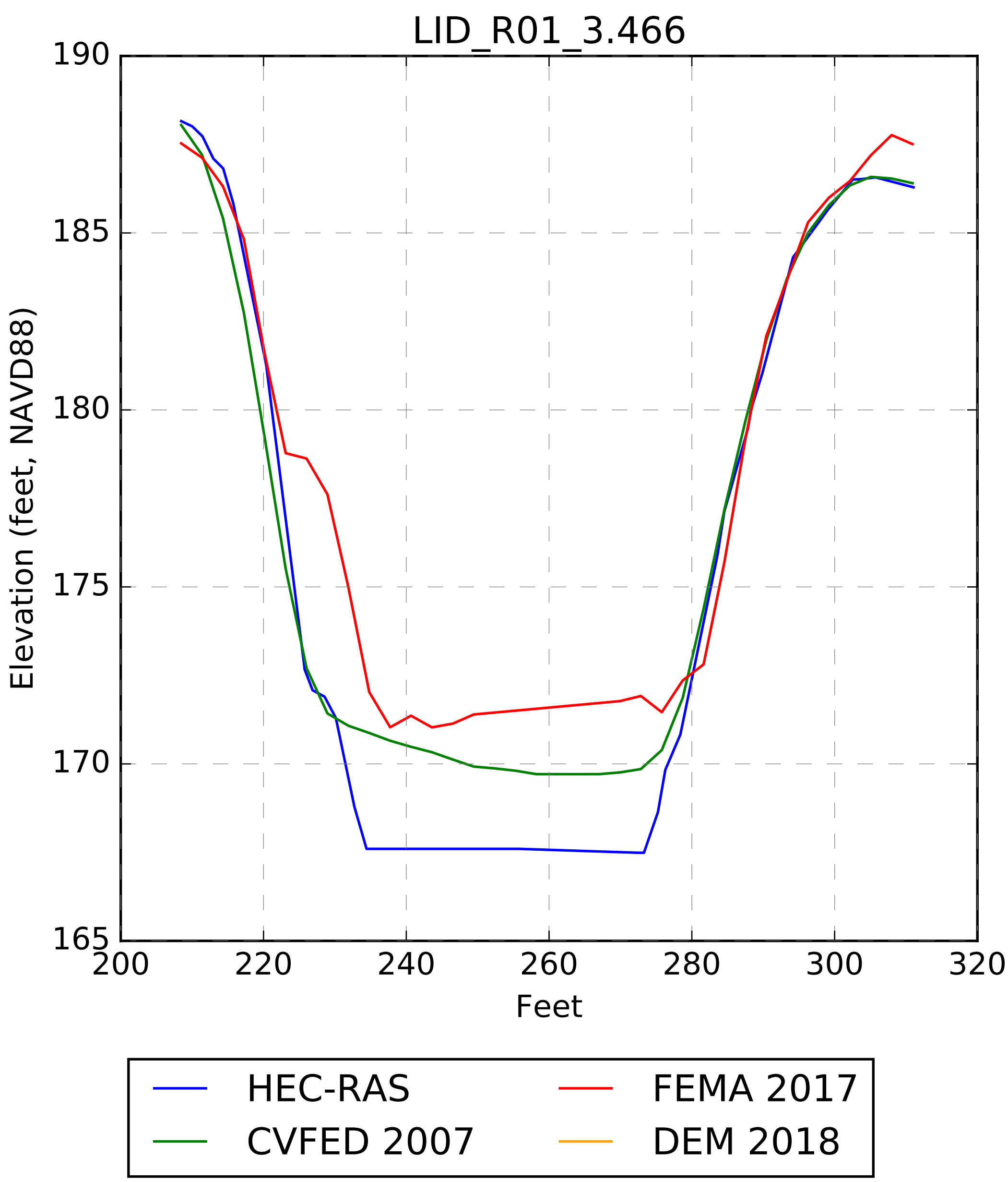
170
165
180
200
220
240
260
280
300
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018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Elevation (feet, NAVD88)
Feet
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180
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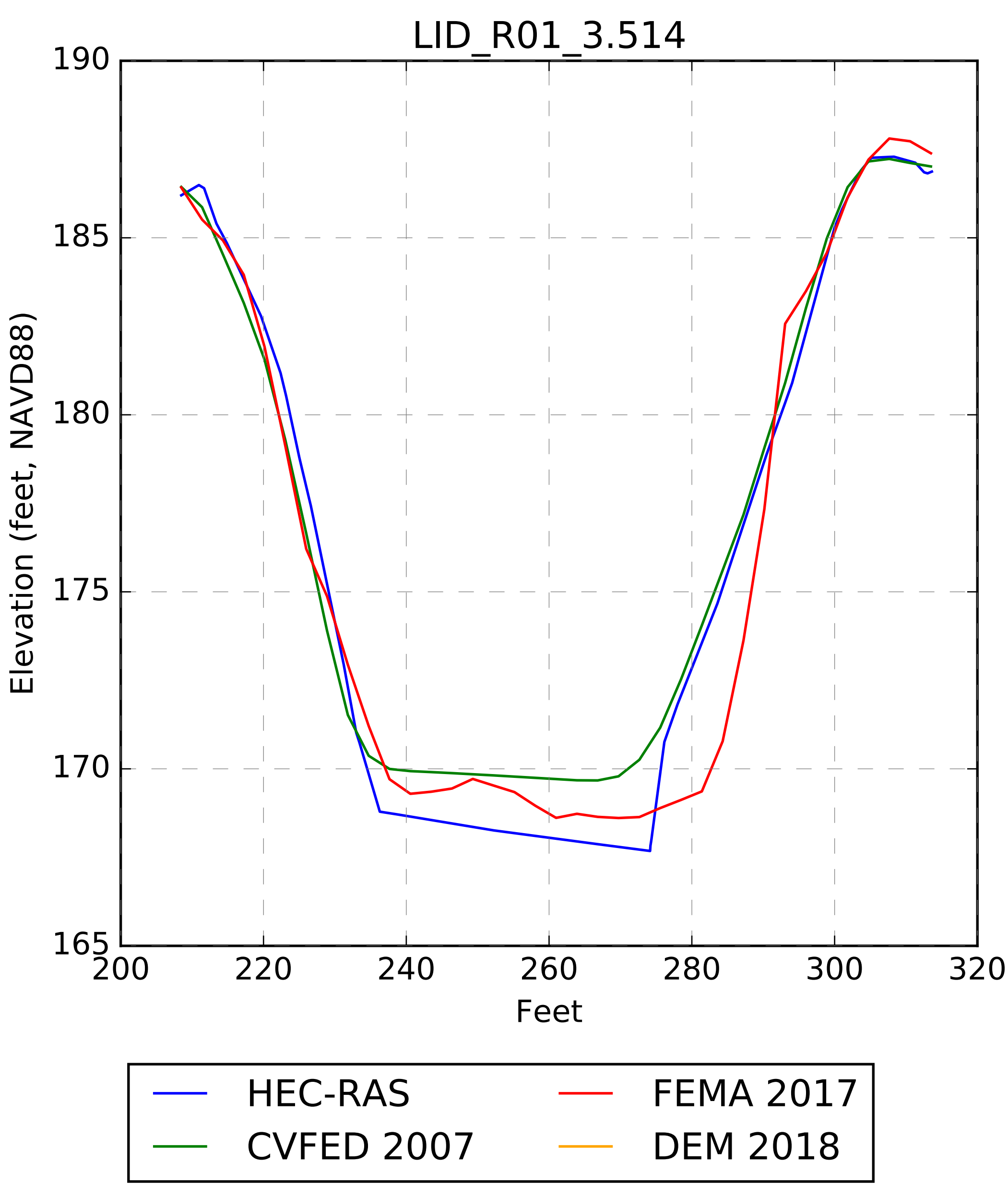
170
165
200
220
240
260
280
300
320
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



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Elevation (feet, NAVD88)
Feet
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170
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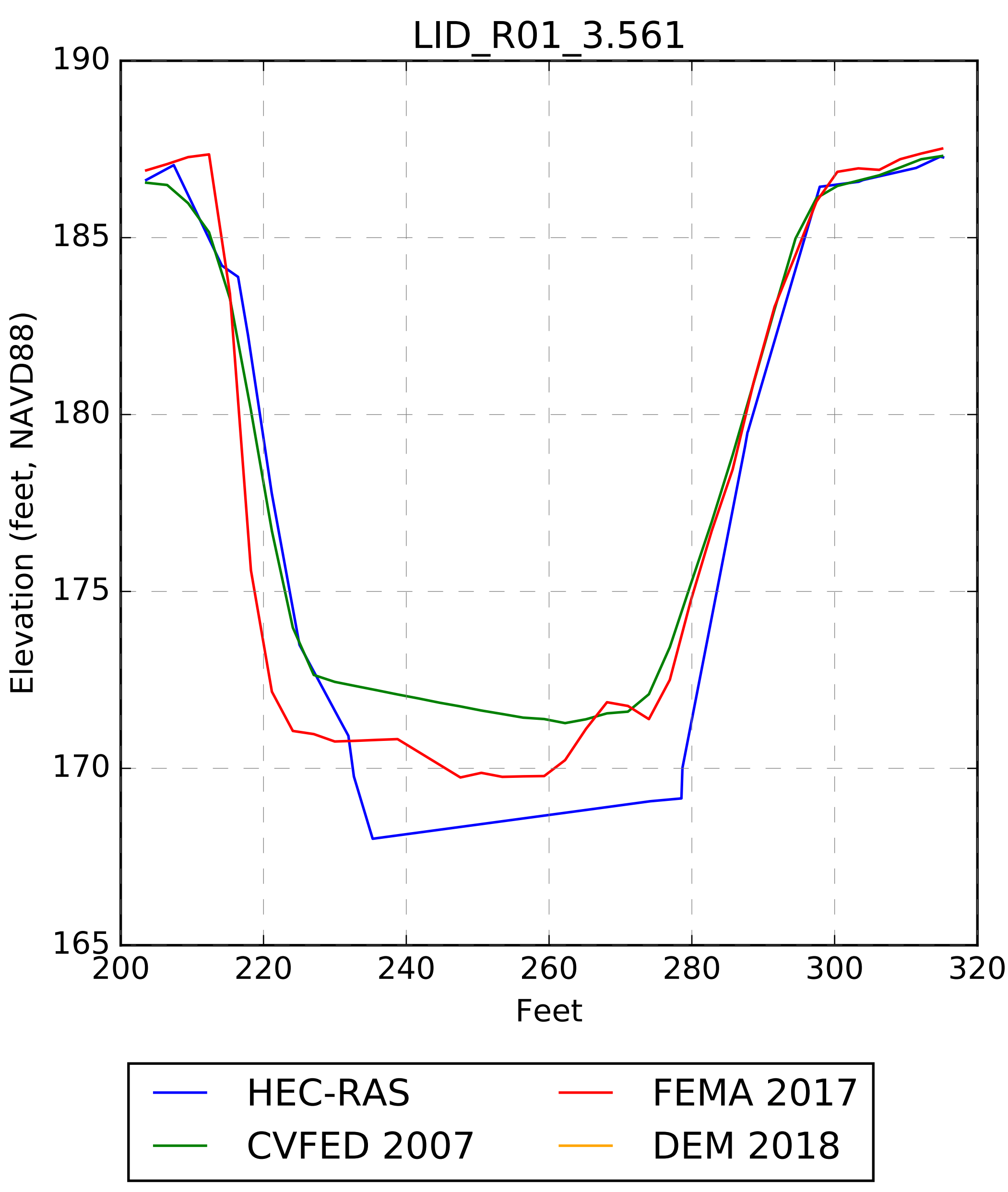
200
220
240
260
280
300
320
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018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Elevation (feet, NAVD88)
Feet
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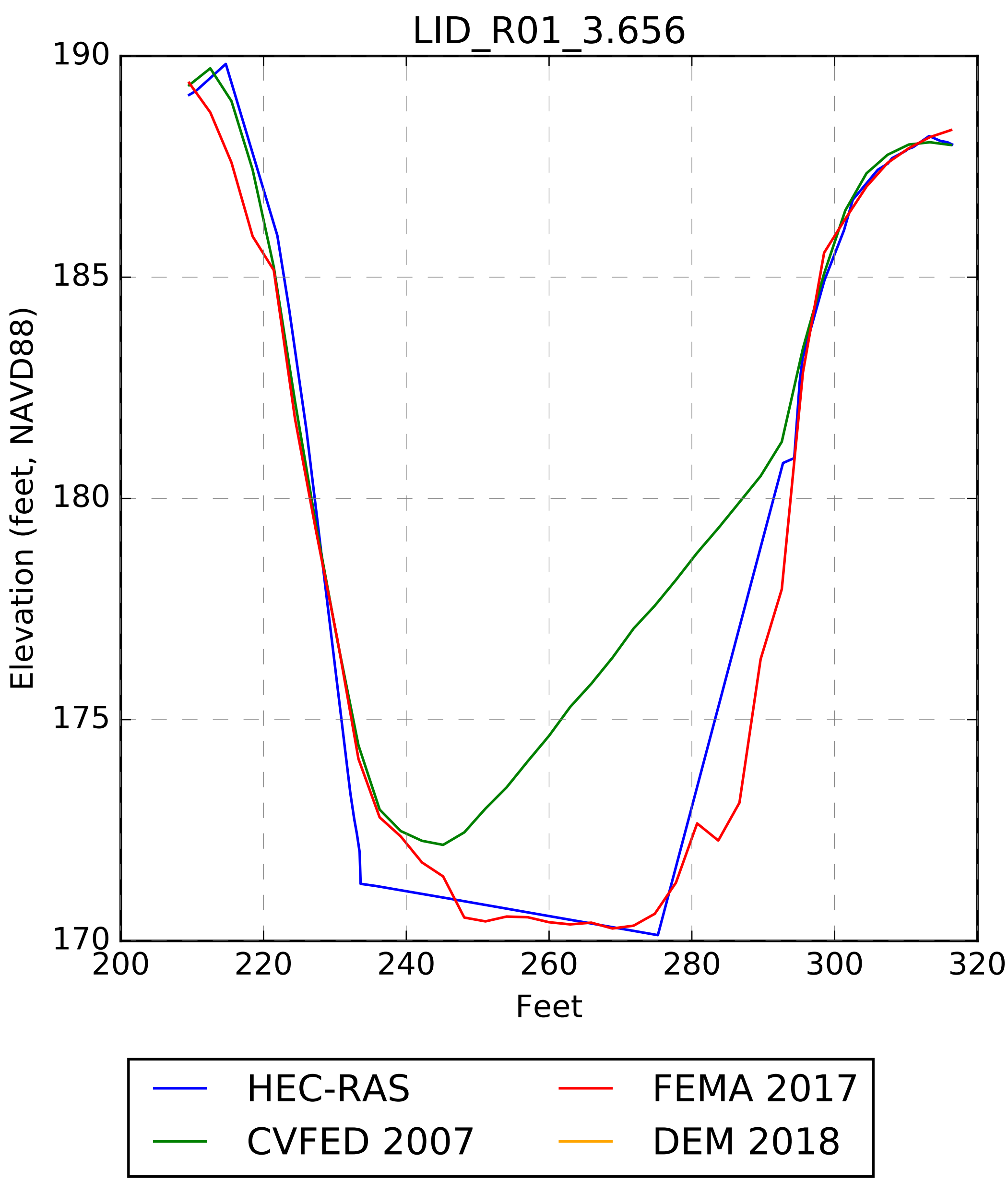
170
165
200
220
240
260
280
300
320
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018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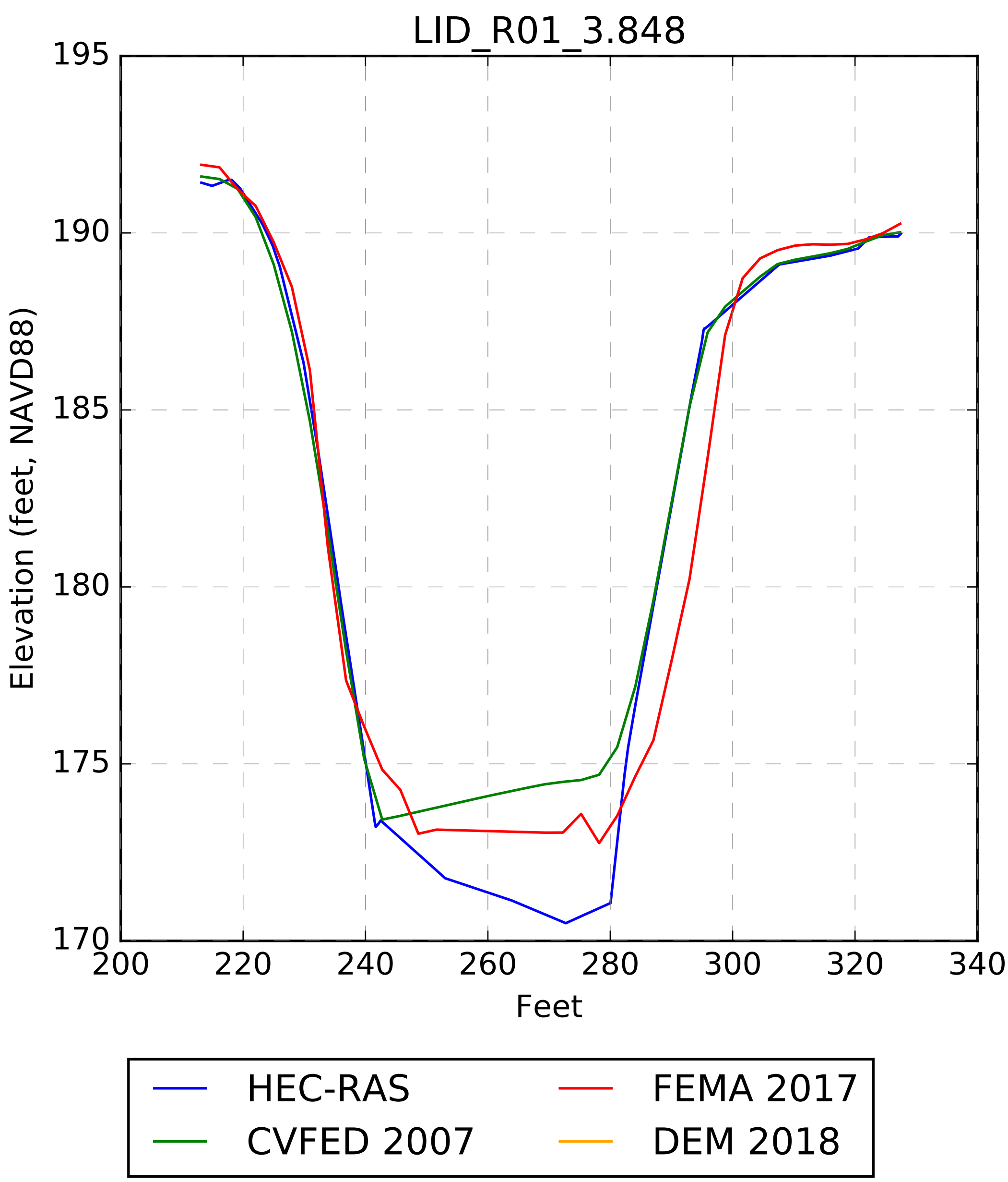
260
280
300
320
Feet
Elevation (feet, NAVD88)
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



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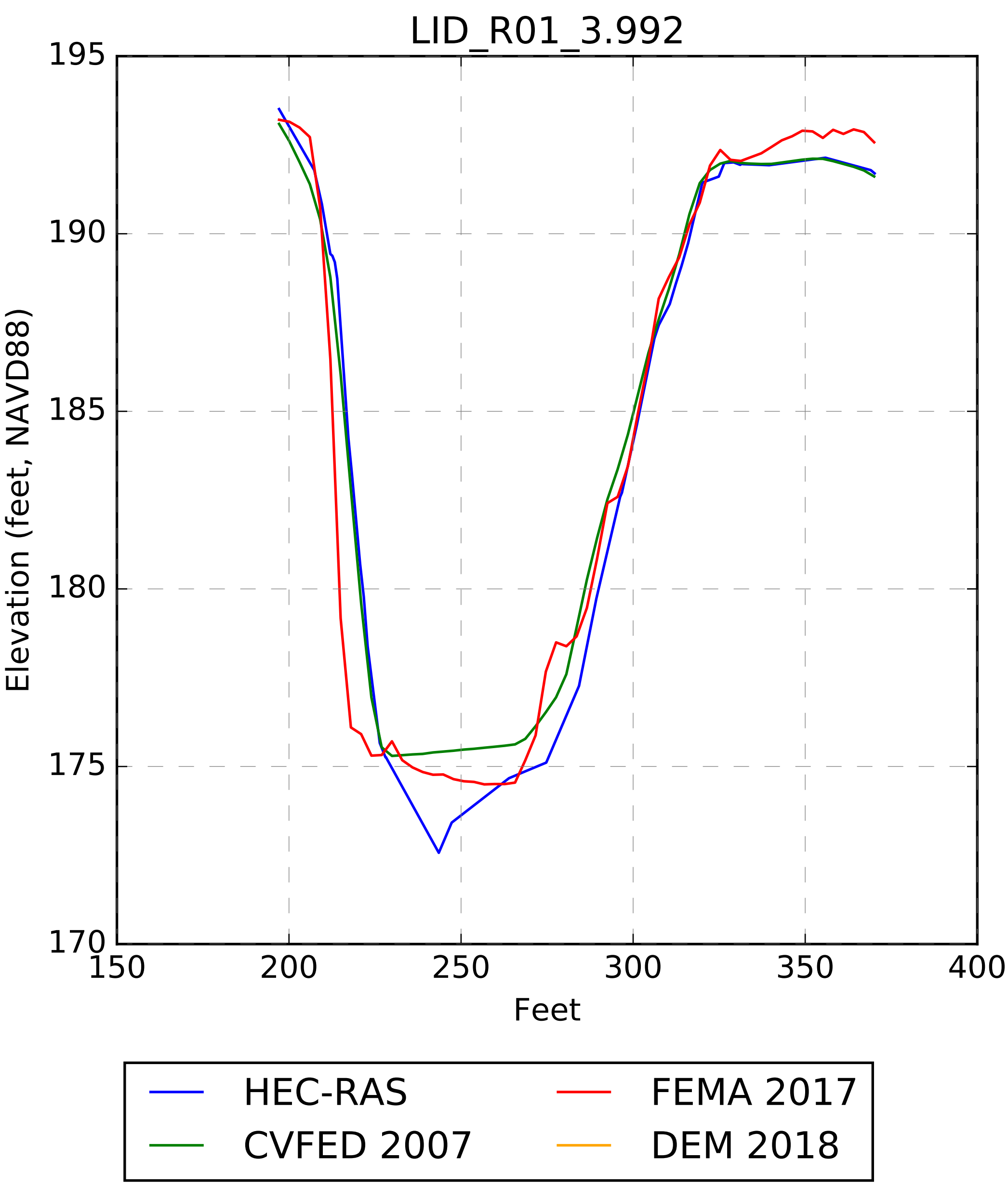
190
185
180
175
170
200
220
240
260
280
300
320
340
Feet
Elevation (feet, NAVD88)
HEC-RAS
FEMA 2017
CVFED 2007
DEM 2018



LID_R01_3.992
Elevation (feet, NAVD88)
Feet
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190
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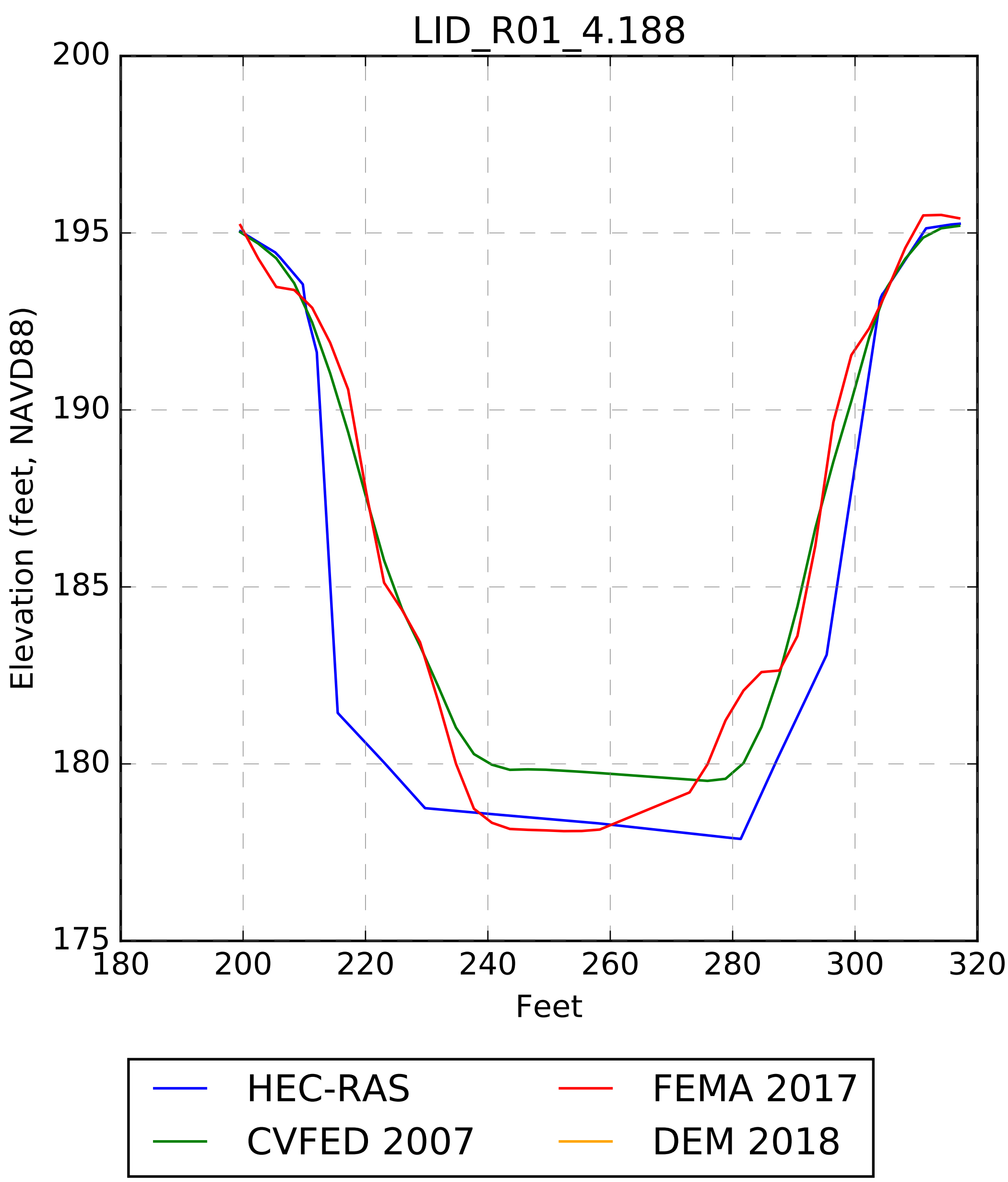
180
175
170
150
200
250
300
350
400
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018



LID_R01_4.188
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195
190
185
180
175
180
200
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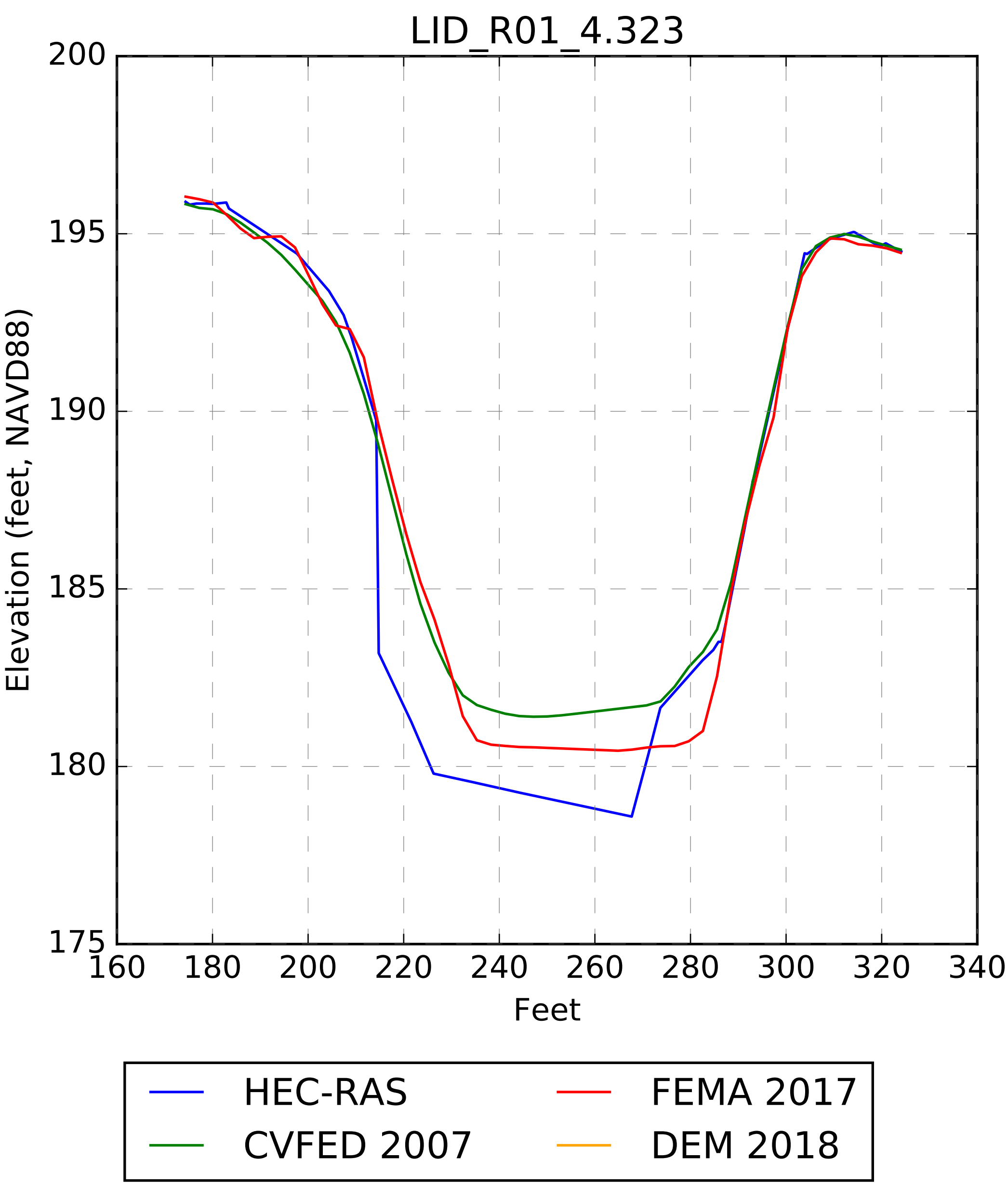
280
300
320
Feet
Elevation (feet, NAVD88)
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018



LID_R01_4.323
200
195
190
185
180
175
160
180
200
220
240
260
280
300
320
340
Feet
Elevation (feet, NAVD88)
HEC-RAS
CVFED 2007
FEMA 2017
DEM 2018

City of Chico

Storm Water Master Plan

Appendix G – Opinions of Probable Cost – Details by Project Groupings

Barber

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	2658.34	$ 412,043	$ 206,021	$ -	$ 618,064
2	15-in Dia. Pipe	L.F.	$ 189	1361	$ 257,179	$ 128,590	$ -	$ 385,769
3	18-in Dia. Pipe	L.F.	$ 223	1504.60	$ 335,527	$ 167,763	$ 2,172	$ 505,462
4	Replace Catch Basin	Ea.	$ 5,500	24	$ 132,000	$ 66,000	$ -	$ 198,000
5	New Catch Basin	Ea.	$ 5,000	27	$ 135,000	$ 67,500	$ -	$ 202,500
6	15-inch Outfall	Ea.	$ 16,000	1	$ 16,000	$ 8,000	$ -	$ 24,000
7	48-inch Manhole	Ea.	$ 12,500	8	$ 100,000	$ 50,000	$ -	$ 150,000
	TOTAL				**$ 1,387,749**	**$ 693,874**	**$ 2,172**	**$ 2,083,795**

Bell Muir

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	4808	$ 745,284	$ 372,642	$ 162,279	$ 1,280,206
2	15-in Dia. Pipe	L.F.	$ 189	3239	$ 612,131	$ 306,066	$ 278,390	$ 1,196,586
3	18-in Dia. Pipe	L.F.	$ 223	6193	$ 1,380,959	$ 690,479	$ 799,709	$ 2,871,147
4	24-in Dia. Pipe	L.F.	$ 297	5667	$ 1,683,139	$ 841,570	$ 392,717	$ 2,917,426
5	30-in Dia. Pipe	L.F.	$ 377	5296	$ 1,996,729	$ 998,364	$ 483,024	$ 3,478,117
6	42-in Dia. Pipe	L.F.	$ 559	1160	$ 648,181	$ 324,090	$ 172,730	$ 1,145,001
7	1-ft D, 2-ft BW Channel		$ 215	669	$ 143,698	$ 71,849	$ 127,035	$ 342,581
8	2-ft D, 2-ft BW Channel		$ 228	1489	$ 339,092	$ 169,546	$ 387,061	$ 895,698
9	2-ft D, 3-ft BW Channel	Ea.	$ 229	1396	$ 320,162	$ 160,081	$ 362,893	$ 843,136
10	2-ft D, 4-ft BW Channel	Ea.	$ 231	1213	$ 280,185	$ 140,092	$ 315,370	$ 735,647
11	3.5-ft D, 10-ft BW Channel	Ea.	$ 279	2928	$ 815,860	$ 407,930	$ 1,068,882	$ 2,292,671
12	Replace Catch Basin	Ea.	$ 5,500	2	$ 11,000	$ 5,500	$ -	$ 16,500
13	New Catch Basin	Ea.	$ 5,000	44	$ 220,000	$ 110,000	$ -	$ 330,000
14	48-inch Manhole	Ea.	$ 12,500	11	$ 137,500	$ 68,750	$ -	$ 206,250
15	60-inch Manhole	Ea.	$ 16,000	1	$ 16,000	$ 8,000	$ -	$ 24,000
16	Bell-Muir Basin 1	Ea.	$ 426,176	1	$ 426,176	$ 213,088	$ 711,961	$ 1,351,225
17	Bell-Muir Basin 2	Ea.	$ 294,815	1	$ 294,815	$ 147,408	$ 461,811	$ 904,034
18	Bell-Muir Basin 3	Ea.	$ 1,359,019	1	$ 1,359,019	$ 679,510	$ 2,576,955	$ 4,615,484
19	Bell-Muir Basin 4	Ea.	$ 1,492,991	1	$ 1,492,991	$ 746,496	$ 2,850,558	$ 5,090,045
	TOTAL				**$ 12,922,919**	**$ 6,461,460**	**$ 11,151,375**	**$ 30,535,754**

Bruce Humboldt

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	2242	$ 347,530	$ 173,765	$ 75,852	$ 597,147
2	New Catch Basin	Ea.	$ 5,000	8	$ 40,000	$ 20,000	$ -	$ 60,000
	TOTAL				**$ 387,530**	**$ 193,765**	**$ 75,852**	**$ 657,147**

Chapman

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	7532	$ 1,167,514	$ 583,757	$ 64,769	$ 1,816,039
2	15-in Dia. Pipe	L.F.	$ 189	741	$ 140,125	$ 70,062	$ 42,742	$ 252,929
3	18-in Dia. Pipe	L.F.	$ 223	340	$ 75,782	$ 37,891	$ -	$ 113,672
4	24-in Dia. Pipe	L.F.	$ 297	317	$ 94,225	$ 47,112	$ 11,858	$ 153,195
5	Replace Catch Basin	Ea.	$ 5,500	19	$ 104,500	$ 52,250	$ -	$ 156,750
6	New Catch Basin	Ea.	$ 5,000	73	$ 365,000	$ 182,500	$ -	$ 547,500
7	48-inch Manhole	Ea.	$ 12,500	10	$ 125,000	$ 62,500	$ -	$ 187,500
8	60-inch Manhole	Ea.	$ 16,000	1	$ 16,000	$ 8,000	$ -	$ 24,000
	TOTAL				**$ 2,088,144**	**$ 1,044,072**	**$ 119,369**	**$ 3,251,586**

East Streets

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	8510	$ 1,319,003	$ 659,502	$ 14,303	$ 1,992,807
2	15-in Dia. Pipe	L.F.	$ 189	1161	$ 219,357	$ 109,678	$ -	$ 329,035
3	30-in Dia. Pipe	L.F.	$ 377	1503	$ 566,615	$ 283,307	$ -	$ 849,922
4	Replace Catch Basin	Ea.	$ 5,500	26	$ 143,000	$ 71,500	$ -	$ 214,500
5	New Catch Basin	Ea.	$ 5,000	44	$ 220,000	$ 110,000	$ -	$ 330,000
6	12-inch Outfall	Ea.	$ 8,000	1	$ 8,000	$ 4,000	$ -	$ 12,000
7	30-inch Outfall	Ea.	$ 37,000	1	$ 37,000	$ 18,500	$ -	$ 55,500
8	48-inch Manhole	Ea.	$ 12,500	18	$ 225,000	$ 112,500	$ -	$ 337,500
	TOTAL				**$ 2,737,975**	**$ 1,368,987**	**$ 14,303**	**$ 4,121,265**

Eaton Road

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	3096	$ 479,830	$ 239,915	$ 8,143	$ 727,887
2	15-in Dia. Pipe	L.F.	$ 189	509	$ 96,138	$ 48,069	$ -	$ 144,207
3	18-in Dia. Pipe	L.F.	$ 223	4197	$ 935,957	$ 467,978	$ 117,715	$ 1,521,650
4	24-in Dia. Pipe	L.F.	$ 297	433	$ 128,532	$ 64,266	$ -	$ 192,798
5	Replace Catch Basin	Ea.	$ 5,500	4	$ 22,000	$ 11,000	$ -	$ 33,000
6	New Catch Basin	Ea.	$ 5,000	24	$ 120,000	$ 60,000	$ -	$ 180,000
7	15-inch Outfall	Ea.	$ 16,000	1	$ 16,000	$ 8,000	$ -	$ 24,000
8	48-inch Manhole	Ea.	$ 12,500	4	$ 50,000	$ 25,000	$ -	$ 75,000
9	Eaton Road Basin	Ea.	$ 343,578	1	$ 343,578	$ 171,789	$ 774,223	$ 1,289,590
	TOTAL				**$ 2,192,034**	**$ 1,096,017**	**$ 900,081**	**$ 4,188,132**

Esplanade

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	6130	$ 950,122	$ 475,061	$ 187,222	$ 1,612,405
2	15-in Dia. Pipe	L.F.	$ 189	1055	$ 199,356	$ 99,678	$ 13,529	$ 312,563
3	18-in Dia. Pipe	L.F.	$ 223	443	$ 98,804	$ 49,402	$ -	$ 148,206
4	24-in Dia. Pipe	L.F.	$ 297	2745	$ 815,329	$ 407,664	$ -	$ 1,222,993
5	30-in Dia. Pipe	L.F.	$ 377	298	$ 112,184	$ 56,092	$ -	$ 168,276
6	42-in Dia. Pipe	L.F.	$ 559	385	$ 215,262	$ 107,631	$ -	$ 322,893
7	Replace Catch Basin	Ea.	$ 5,500	8	$ 44,000	$ 22,000	$ -	$ 66,000
8	New Catch Basin	Ea.	$ 5,000	40	$ 200,000	$ 100,000	$ -	$ 300,000
9	24-inch Outfall	Ea.	$ 30,000	1	$ 30,000	$ 15,000	$ -	$ 45,000
10	48-inch Manhole	Ea.	$ 12,500	8	$ 100,000	$ 50,000	$ -	$ 150,000
11	60-inch Manhole	Ea.	$ 16,000	2	$ 32,000	$ 16,000	$ -	$ 48,000
	TOTAL				**$ 2,797,056**	**$ 1,398,528**	**$ 200,751**	**$ 4,396,336**

Fair Street Area

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	1583	$ 245,346	$ 122,673	$ 49,321	$ 417,340
2	New Catch Basin	Ea.	$ 5,000	14	$ 70,000	$ 35,000	$ -	$ 105,000
3	12-inch Outfall	Ea.	$ 8,000	1	$ 8,000	$ 4,000	$ -	$ 12,000
4	48-inch Manhole	Ea.	$ 12,500	3	$ 37,500	$ 18,750	$ -	$ 56,250
5	60-inch Manhole	Ea.	$ 16,000	1	$ 16,000	$ 8,000	$ -	$ 24,000
	TOTAL				**$ 376,846**	**$ 188,423**	**$ 49,321**	**$ 614,590**

Glenwood

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	2158	$ 334,526	$ 167,263	$ 500	$ 502,288
2	15-in Dia. Pipe	L.F.	$ 189	47	$ 8,908	$ 4,454	$ 500	$ 13,862
3	30-in Dia. Pipe	L.F.	$ 377	124	$ 46,861	$ 23,431	$ -	$ 70,292
4	36-in Dia. Pipe	L.F.	$ 465	1293	$ 601,201	$ 300,601	$ -	$ 901,802
5	42-in Dia. Pipe	L.F.	$ 559	428	$ 239,095	$ 119,547	$ -	$ 358,642
6	48-in Dia. Pipe	L.F.	$ 659	1267	$ 835,037	$ 417,519	$ -	$ 1,252,556
7	Replace Catch Basin	Ea.	$ 5,500	2	$ 11,000	$ 5,500	$ -	$ 16,500
8	New Catch Basin	Ea.	$ 5,000	2	$ 10,000	$ 5,000	$ -	$ 15,000
9	12-inch Outfall	Ea.	$ 8,000	1	$ 8,000	$ 4,000	$ -	$ 12,000
10	48-inch Manhole	Ea.	$ 12,500	2	$ 25,000	$ 12,500	$ -	$ 37,500
11	60-inch Manhole	Ea.	$ 16,000	4	$ 64,000	$ 32,000	$ -	$ 96,000
12	72-inch Manhole	Ea.	$ 21,000	3	$ 63,000	$ 31,500	$ -	$ 94,500
	TOTAL				**$ 2,246,628**	**$ 1,123,314**	**$ 1,000**	**$ 3,370,942**

Lindo

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	3426	$ 531,099	$ 265,550	$ -	$ 796,649
2	15-in Dia. Pipe	L.F.	$ 189	577	$ 109,143	$ 54,572	$ -	$ 163,715
3	18-in Dia. Pipe	L.F.	$ 223	96	$ 21,447	$ 10,723	$ -	$ 32,170
4	24-in Dia. Pipe	L.F.	$ 297	466	$ 138,402	$ 69,201	$ 37,562	$ 245,165
5	New Catch Basin	Ea.	$ 5,000	21	$ 105,000	$ 52,500	$ -	$ 157,500
6	12-inch Outfall	Ea.	$ 8,000	4	$ 32,000	$ 16,000	$ -	$ 48,000
7	48-inch Manhole	Ea.	$ 12,500	5	$ 62,500	$ 31,250	$ -	$ 93,750
	TOTAL				**$ 999,591**	**$ 499,796**	**$ 37,562**	**$ 1,536,949**

Lindo South

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	162	$ 25,044	$ 12,522	$ -	$ 37,565
2	New Catch Basin	Ea.	$ 5,000	6	$ 30,000	$ 15,000	$ -	$ 45,000
3	12-inch Outfall	Ea.	$ 8,000	2	$ 16,000	$ 8,000	$ -	$ 24,000
	TOTAL				**$ 71,044**	**$ 35,522**	**$ -**	**$ 106,565**

Little Chico Creek - South

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	1957	$ 303,275	$ 151,637	$ 17,911	$ 472,823
2	15-in Dia. Pipe	L.F.	$ 189	435	$ 82,127	$ 41,063	$ -	$ 123,190
3	18-in Dia. Pipe	L.F.	$ 223	816	$ 181,968	$ 90,984	$ 118,950	$ 391,902
4	Replace Catch Basin	Ea.	$ 5,500	4	$ 22,000	$ 11,000	$ -	$ 33,000
5	New Catch Basin	Ea.	$ 5,000	9	$ 45,000	$ 22,500	$ -	$ 67,500
6	12-inch Outfall	Ea.	$ 8,000	1	$ 8,000	$ 4,000	$ -	$ 12,000
7	48-inch Manhole	Ea.	$ 12,500	6	$ 75,000	$ 37,500	$ -	$ 112,500
	TOTAL				**$ 717,370**	**$ 358,685**	**$ 136,861**	**$ 1,212,916**

Mansion Park NE

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	7506	$ 1,163,427	$ 581,713	$ 1,422	$ 1,746,562
2	15-in Dia. Pipe	L.F.	$ 189	2200	$ 415,749	$ 207,874	$ -	$ 623,623
3	18-in Dia. Pipe	L.F.	$ 223	802	$ 178,917	$ 89,459	$ -	$ 268,376
4	24-in Dia. Pipe	L.F.	$ 297	146	$ 43,293	$ 21,646	$ -	$ 64,939
5	30-in Dia. Pipe	L.F.	$ 377	1247	$ 470,236	$ 235,118	$ -	$ 705,354
6	36-in Dia. Pipe	L.F.	$ 465	535	$ 248,781	$ 124,391	$ -	$ 373,172
7	42-in Dia. Pipe	L.F.	$ 559	473	$ 264,596	$ 132,298	$ -	$ 396,894
8	Replace Catch Basin	Ea.	$ 5,500	6	$ 33,000	$ 16,500	$ -	$ 49,500
9	New Catch Basin	Ea.	$ 5,000	60	$ 300,000	$ 150,000	$ -	$ 450,000
10	12-inch Outfall	Ea.	$ 8,000	3	$ 24,000	$ 12,000	$ -	$ 36,000
11	48-inch Manhole	Ea.	$ 12,500	12	$ 150,000	$ 75,000	$ -	$ 225,000
12	60-inch Manhole	Ea.	$ 16,000	2	$ 32,000	$ 16,000	$ -	$ 48,000
	TOTAL				**$ 3,324,000**	**$ 1,662,000**	**$ 1,422**	**$ 4,987,421**

Mansion Park SW

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	10949	$ 1,697,074	$ 848,537	$ 138,466	$ 2,684,078
2	15-in Dia. Pipe	L.F.	$ 189	2689	$ 508,287	$ 254,143	$ 59,804	$ 822,234
3	18-in Dia. Pipe	L.F.	$ 223	1957	$ 436,339	$ 218,170	$ 37,534	$ 692,043
4	24-in Dia. Pipe	L.F.	$ 297	1525	$ 453,042	$ 226,521	$ 67,461	$ 747,024
5	30-in Dia. Pipe	L.F.	$ 377	1845	$ 695,617	$ 347,808	$ 59,925	$ 1,103,350
6	36-in Dia. Pipe	L.F.	$ 465	2851	$ 1,325,571	$ 662,785	$ -	$ 1,988,356
7	42-in Dia. Pipe	L.F.	$ 559	2718	$ 1,519,226	$ 759,613	$ -	$ 2,278,839
8	Replace Catch Basin	Ea.	$ 5,500	5	$ 27,500	$ 13,750	$ -	$ 41,250
9	New Catch Basin	Ea.	$ 5,000	79	$ 395,000	$ 197,500	$ -	$ 592,500
10	12-inch Outfall	Ea.	$ 8,000	1	$ 8,000	$ 4,000	$ -	$ 12,000
11	48-inch Manhole	Ea.	$ 12,500	11	$ 137,500	$ 68,750	$ -	$ 206,250
12	84-inch Manhole	Ea.	$ 29,000	1	$ 29,000	$ 14,500	$ -	$ 43,500
	TOTAL				**$ 7,232,156**	**$ 3,616,078**	**$ 363,189**	**$ 11,211,423**

Mulberry

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	1454	$ 225,415	$ 112,707	$ 2,982	$ 341,104
2	15-in Dia. Pipe	L.F.	$ 189	396	$ 74,764	$ 37,382	$ -	$ 112,145
3	New Catch Basin	Ea.	$ 5,000	12	$ 60,000	$ 30,000	$ -	$ 90,000
4	48-inch Manhole	Ea.	$ 12,500	3	$ 37,500	$ 18,750	$ -	$ 56,250
5	60-inch Manhole	Ea.	$ 16,000	1	$ 16,000	$ 8,000	$ -	$ 24,000
	TOTAL				**$ 413,679**	**$ 206,839**	**$ 2,982**	**$ 623,500**

Nord Avenue

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	1136	$ 176,145	$ 88,072	$ 500	$ 264,717
2	15-in Dia. Pipe	L.F.	$ 189	608	$ 114,853	$ 57,427	$ -	$ 172,280
3	18-in Dia. Pipe	L.F.	$ 223	2099	$ 468,007	$ 234,003	$ -	$ 702,010
4	24-in Dia. Pipe	L.F.	$ 297	2944	$ 874,375	$ 437,188	$ -	$ 1,311,563
5	24-inch Outfall	Ea.	$ 30,000	1	$ 30,000	$ 15,000	$ -	$ 45,000
6	48-inch Manhole	Ea.	$ 12,500	15	$ 187,500	$ 93,750	$ -	$ 281,250
	TOTAL				**$ 1,850,880**	**$ 925,440**	**$ 500**	**$ 2,776,820**

North Chico

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	North Chico Basin	Ea.	$ 6,168,969	1	$ 6,168,969	$ 3,084,485	$ 6,281,670	$ 15,535,124
2	North Chico Pump Station	Ea.	$ 13,700,000	1	$ 13,700,000	$ 6,850,000	$ -	$ 20,550,000
	TOTAL				**$ 19,868,969**	**$ 9,934,485**	**$ 6,281,670**	**$ 36,085,124**

Park Vista

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	34	$ 5,314	$ 2,657	$ -	$ 7,971
2	15-in Dia. Pipe	L.F.	$ 189	86	$ 16,176	$ 8,088	$ -	$ 24,264
3	18-in Dia. Pipe	L.F.	$ 223	1135	$ 253,154	$ 126,577	$ -	$ 379,731
4	New Catch Basin	Ea.	$ 5,000	6	$ 30,000	$ 15,000	$ -	$ 45,000
	TOTAL				**$ 304,644**	**$ 152,322**	**$ -**	**$ 456,967**

South Campus

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	7638	$ 1,183,957	$ 591,979	$ 83,325	$ 1,859,260
2	15-in Dia. Pipe	L.F.	$ 189	2560	$ 483,762	$ 241,881	$ -	$ 725,643
3	18-in Dia. Pipe	L.F.	$ 223	370	$ 82,531	$ 41,265	$ -	$ 123,796
4	Replace Catch Basin	Ea.	$ 5,500	14	$ 77,000	$ 38,500	$ -	$ 115,500
5	New Catch Basin	Ea.	$ 5,000	75	$ 375,000	$ 187,500	$ -	$ 562,500
6	12-inch Outfall	Ea.	$ 8,000	1	$ 8,000	$ 4,000	$ -	$ 12,000
7	48-inch Manhole	Ea.	$ 12,500	13	$ 162,500	$ 81,250	$ -	$ 243,750
	TOTAL				**$ 2,372,750**	**$ 1,186,375**	**$ 83,325**	**$ 3,642,449**

South Entler

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	South Entler Basin	Ea.	$ 1,060,913	4	$ 4,243,652	$ 2,121,826	$ 5,066,536	$ 11,432,014
	TOTAL				**$ 4,243,652**	**$ 2,121,826**	**$ 5,066,536**	**$ 11,432,014**

Stewart Avenue

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	1139	$ 176,526	$ 88,263	$ 907	$ 265,696
2	New Catch Basin	Ea.	$ 5,000	4	$ 20,000	$ 10,000	$ -	$ 30,000
	TOTAL				**$ 196,526**	**$ 98,263**	**$ 907**	**$ 295,696**

SUDAD East

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	2503	$ 387,899	$ 193,950	$ 61,364	$ 643,213
2	15-in Dia. Pipe	L.F.	$ 189	284	$ 53,662	$ 26,831	$ 33,298	$ 113,791
3	Replace Catch Basin	Ea.	$ 5,500	3	$ 16,500	$ 8,250	$ -	$ 24,750
4	New Catch Basin	Ea.	$ 5,000	11	$ 55,000	$ 27,500	$ -	$ 82,500
5	12-inch Outfall	Ea.	$ 8,000	1	$ 8,000	$ 4,000	$ -	$ 12,000
6	48-inch Manhole	Ea.	$ 12,500	3	$ 37,500	$ 18,750	$ -	$ 56,250
7	SUDAD - East Basin	Ea.	$ 213,087	1	$ 213,087	$ 106,544	$ 292,586	$ 612,217
	TOTAL				**$ 771,649**	**$ 385,824**	**$ 387,248**	**$ 1,544,721**

SUDAD West

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	838	$ 129,847	$ 64,924	$ 80,764	$ 275,535
2	30-in Dia. Pipe	L.F.	$ 377	42	$ 15,696	$ 7,848	$ -	$ 23,544
3	Replace Catch Basin	Ea.	$ 5,500	1	$ 5,500	$ 2,750	$ -	$ 8,250
4	New Catch Basin	Ea.	$ 5,000	5	$ 25,000	$ 12,500	$ -	$ 37,500
5	48-inch Manhole	Ea.	$ 12,500	2	$ 25,000	$ 12,500	$ -	$ 37,500
	TOTAL				**$ 201,043**	**$ 100,521**	**$ 80,764**	**$ 382,328**

Vallombrosa

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Easement/ Acquisition	Total Cost
1	12-in Dia. Pipe	L.F.	$ 155	7397	$ 1,146,569	$ 573,284	$ 500	$ 1,720,353
2	15-in Dia. Pipe	L.F.	$ 189	571	$ 107,848	$ 53,924	$ 75,283	$ 237,055
3	18-in Dia. Pipe	L.F.	$ 223	674	$ 150,394	$ 75,197	$ -	$ 225,591
4	24-in Dia. Pipe	L.F.	$ 297	1323	$ 392,919	$ 196,460	$ 36,549	$ 625,928
5	Replace Catch Basin	Ea.	$ 5,500	9	$ 49,500	$ 24,750	$ -	$ 74,250
6	New Catch Basin	Ea.	$ 5,000	59	$ 295,000	$ 147,500	$ -	$ 442,500
7	12-inch Outfall	Ea.	$ 8,000	10	$ 80,000	$ 40,000	$ -	$ 120,000
8	48-inch Manhole	Ea.	$ 12,500	2	$ 25,000	$ 12,500	$ -	$ 37,500
9	60-inch Manhole	Ea.	$ 16,000	1	$ 16,000	$ 8,000	$ -	$ 24,000
	TOTAL				**$ 2,263,230**	**$ 1,131,615**	**$ 112,332**	**$ 3,507,177**

City of Chico

Storm Water Master Plan

Appendix H – Draft Hydraulic Assessment and Conceptual Design Memorandum for Big Chico Creek Erosion Repair

Prepared by: Dokken Engineering

Dated: July 28, 2022

DOKKEN ENGINEERING

DRAFT HYDRAULIC ASSESSMENT AND CONCEPTUAL DESIGN MEMORANDUM

ATTENTION:	**Mike Cook, Project Manager, City of Chico, Public Works - Engineering**
FROM:	**Rob Burns, SE, Dokken Engineering**
PROJECT:	**On-Call Services for Structural Engineering: Task Order No. 2 – Big Chico Creek Erosion Repair**
DATE:	**July 28, 2022**

1. BACKGROUND

1.1 Project Description

The City of Chico proposes to analyze 10 sites along Big Chico Creek for scour repairs as part of the Big Chico Creek Scour Assessment project. There are 9 sites of localized scour along Big Chico Creek all located within Bidwell Park. The tenth location of scour along Big Chico Creek is at the Warner Street Bridge located on the Chico State University Campus. See Figure 1 for the Project Location map showing all 10 sites along Big Chico Creek.

Upstream of the project there is a diversion structure that alters the discharge patterns of Big Chico Creek. During past large storm events there have been some mismanagements of the diversion structure and increased flows were sent to Big Chico Creek rather than Lindo Channel. The increased flows sent to Big Chico Creek likely contributed to the localized erosion.

1.2 Memo Objective

The purpose of this memorandum is to document the site conditions, hydraulic assessment, proposed erosion control improvements, and cost estimates for the repair of the 10 scour locations along Big Chico Creek located in the City of Chico. The City of Chico will utilize the conceptual design and preliminary estimates for the purpose of requesting funding and scoping future work.

2. BIG CHICO CREEK

2.1 Watershed, Drainage Patterns, Channel Type

Big Chico Creek is located in Butte County and receives runoff from the City of Chico and surrounding rural land. The creek has a natural channel with a variety of native and non-native trees, shrubs, and grasses that grow along the channel banks and in the channel itself. Meandering through the City of Chico, the creek is approximately 45 miles long and has a contributing watershed of approximately 240 square miles. Big Chico Creek flows southwesterly and ultimately terminates at its confluence with the Sacramento River. It has a diversion structure located just downstream of the Five Mile recreation area within Bidwell Park, which diverts excess flows from Big Chico into Lindo Channel and Sycamore Creek.

Figure 1 - Project Location Map
Big Chico Creek Erosion Repair
Legend
Big Chico Creek
Sites
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
Site 9
Site 10 - Warner Street Bridge
East Ave
Cohasset Rd
Shasta Ave
Esplanade
Manzanita Ave
Deer Creek Hwy
Eigth St
Walnut St
Wetn St
99
32
Google Earth
Image Landsat / Copernicus
1 mi
N

2.2 Land Uses

The majority of the project, 9 out of 10 sites, is located in Bidwell Park in the City of Chico. Bidwell Park consists primarily of park land, park roads, and adjacent residential homes. The Warner Street Bridge site is located on the CSU, Chico campus, where the creek remains in a relatively natural state, surrounded by the urbanized environment of the university campus. The land in the surrounding area is covered with grass and shrubs, and there is dense tree cover along Big Chico Creek and throughout Bidwell Park. Because land adjacent to Big Chico Creek in the project area is mostly parks, the creek is heavily used for recreation and aesthetic purposes by city residents and visitors.

2.3 Soils, Infiltration Rates, and Groundwater

Based on surveys performed by the National Resource Conservation Service (NRCS) *Web Soil Survey*, the project site generally consists of the following soil units:

Table 1: Soils in the Project Area

Soil ID	Soil Description	Hydrologic Soil Group	Percentage of Project Area*
300	Redsluff gravelly loam, 0 to 2 percent slopes	C	4.7%
418	Almendra loam, 0 to 1 percent slopes	B	8.2%
425	Vina fine sandy loam, sandy substratum, 0 to 2 percent slopes, MLRA 17	A	55.1%
447	Charger fine sandy loam, 0 to 1 percent slopes	A	28.7%
991	Xerofluvents, 0 to 4 percent slopes frequently flooded	B	3.3%

*See Appendix A for the Project Area map within the NRCS Soil Report.

As shown in Table 1, a mix of loams, sandy loams, and gravelly loams make up approximately 96.7% of the soil types in the overall project area, with the remaining 3.3% of the project area classified as Xerofluvents. The majority of the soils belong to Hydrologic Soil Groups A and B, which are characterized by low runoff potential and high infiltration/water transmission rates when thoroughly wet. The full NRCS Soil Resource Report for the project site can be found in Appendix A.

The California Department of Water Resources (DWR) database indicates that the nearest well to the project site, Well 22N02E18J001M, had an average groundwater elevation of 147.0 feet and a depth of 132.3 feet from 2001 to 2021. The nearest well was between 0.7 and 4.0 miles from the project sites. Based on the proximity of the well to the project site, more detailed groundwater data will be acquired in final design. Groundwater flow direction is expected to be locally variable based upon specific topography, drainage patterns, and geologic conditions.

2.4 Existing Conditions

Dokken Engineering and the City performed a site visit of the 10 erosion sites on October 14, 2021. The following sections document the conditions at each of the site locations.

2.4.1 Site 1

Site 1 is located just northeast of the CA-99 crossing of Big Chico Creek. Site 1 has localized erosion along the bank that is approximately 60 feet in length, 5 feet wide, and approximately 8 feet high. There are some existing shrubs and bushes along the bank. Logs are piled up along the bank as a temporary erosion protection measure. See Figure 2 for a photo of the scour at Site 1.

Figure 2: Site 1 Erosion and Characteristics (Looking downstream)

2.4.2 Site 2

Site 2 is located slightly upstream of Site 1. The erosion damage is approximately 20 feet in length, 5 feet in width, and 8 feet high. This location has trees in a variety of sizes as well as shrubs and grasses. There are existing concrete blocks at this location that were likely once an erosion control measure. See Figures 3 and 4 for photos of the erosion at Site 2.

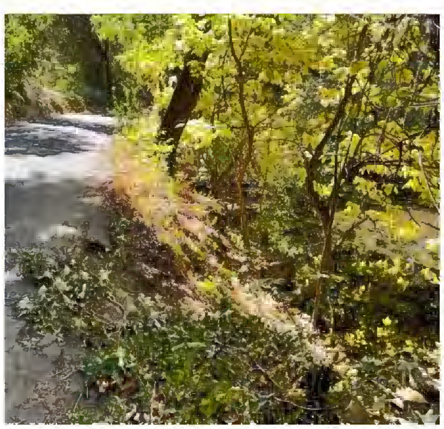


Figure 3: Site 2 Erosion and Characteristics (Looking downstream)

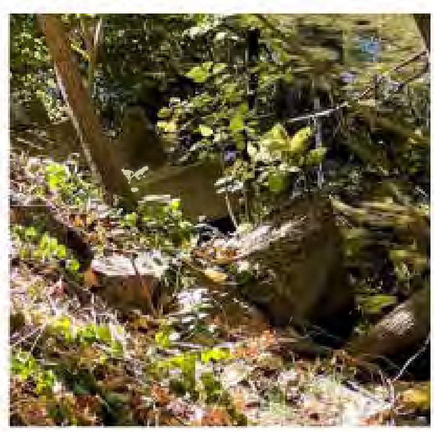


Figure 4: Site 2 Concrete Blocks (Looking downstream)

2.4.3 Site 3

Site 3 is located upstream of Site 2 and just slightly downstream of Site 4. The site is located at an area in Big Chico Creek that has a gravel island in the center of the creek, causing a split flow condition. The gravel island pushes more flow toward the erosion site along the bank, which contributes to the localized erosion at this site. There are some grasses and shrubs in this location, as well as some trees around the project site. The erosion at this location is approximately 80 feet in length, 6 feet wide, and 6 feet high. See Figures 5 and 6 for photos of the erosion at Site 3.

Figure 5: Site 3 Erosion and Characteristics (Looking downstream)

Figure 6: Site 3 Gravel Island with Vegetation (Looking upstream)

2.4.4 Site 4

Site 4 is located just upstream of Site 3. The bank erosion, which is approximately 50 feet in length, up to 10 feet wide, and 10 feet high, has exposed nearby tree roots. The site is covered in some grasses and bushes. The erosion at this site is the worst at the downstream end and the erosion size tapers in the upstream direction. See Figure 7 for a photo of the site.

Figure 7: Site 4 Erosion and Characteristics (Looking downstream)

2.4.5 Site 5

Site 5 is located along South Park Drive, southwest of the intersection of South Park Drive and Centennial Avenue. The channel bank at this site is overgrown with native and non-native vegetation, and some logs have been placed at the bottom of the bank to serve as a temporary erosion control measure. The erosion at this site is approximately 100 feet in length, 5 feet wide, and 10 feet high. See Figure 8 for a view of the erosion at Site 5.

Figure 8: Site 5 Erosion and Characteristics (Looking perpendicular)

2.4.6 Site 6

Site 6 is located in Hooker Oak Park, just downstream of the Big Chico Creek diversion structure. The bank of the channel at this location has been eroded, exposing nearby tree roots. This is a site where recreational use of the creek is common, with heavy foot traffic likely contributing to the scour at this location. This site has some grasses and tree roots exposed along the scour length. See Figure 9 for a depiction of erosion at the Site 6.

Figure 9: Site 6 Erosion and Characteristics (Looking upstream)

2.4.7 Site 7

Site 7 is located slightly upstream from Site 6, inside Hooker Oak Park. Site 7 has scour on the outside of a fence. The erosion at the bank has a steep drop off and there are shrubs surrounding the project site. See Figure 10 for a photo of the scour at Site 7.

Figure 10: Site 7 Erosion and Characteristics (Looking upstream)

2.4.8 Site 8

Site 8 is located just downstream of the intersection of Manzanita Avenue and Vallombrosa Avenue. This location of scour is the most severe of all of the sites. The bank of the creek has significant erosion at the base. This location is a common recreation area during summertime where the public jumps off the top of bank into the creek. The scour has undercut the bank, creating a "cave" that is exposed during normal flows. The recreation activity at this location could also be a contributing factor to the erosion at that site. The erosion damage is approximately 80 feet in length, 8 feet in width, and 15 feet high. See Figure 11 for an illustration of the scour.

Figure 11: Site 8 Erosion and Characteristics (Looking perpendicular)

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2.4.9 Site 9

Site 9 along Big Chico Creek is located near the Chico Area Recreation & Park District (CARD), Community Center. There is a rose garden located on the CARD community center property that is adjacent to the trail. The creek has a small area of localized erosion of the soil near a small tree The length of scour is approximately 35 feet, the width is 10 feet, and the height is 9 feet. See Figure 12 for a picture of the scour.

Figure 12: Site 9 Erosion and Characteristics (Looking downstream)

2.4.10 Warner Street Bridge

The Warner Street Bridge site has several issues creating scour problems. There is a buildup of sediment near the southern bank that causes flow to concentrate at the northern bank (see Figure 15). This has resulted in localized scour at the abutment of the bridge and adjacent banks (Figure 13). The scour at the bed of the Creek has exposed a waterline in the channel (Figure 14).

Figure 13: Warner St Bridge Scour

Figure 14: Exposed Waterline

Figure 15: Site 9 Warner St Bridge Sediment Buildup (Looking downstream)

3. Hydrologic Data

The hydrologic data for Big Chico Creek was a critical piece of data to collect for the purpose of designing erosion protection measures at each of the sites. Peak flows for this project were collected in order to adequately design erosion control devices to protect the banks and bed of the creek from scour. The 100-year storm frequency was used to design the erosion control measures.

Hydrology data was available from DWR and the Federal Emergency Management Agency (FEMA). DWR conducted a study of Big Chico Creek and created a hydraulic model to analyze the channel. The DWR data showed a 100-year peak flow of 1,500 cubic feet per second (cfs) through the project sites along Big Chico Creek. FEMA produced a Flood Insurance Study for Butte County, California and Incorporated Areas. In the flood insurance study, the 100-year peak flow for Big Chico Creek is recorded at 1,400 cubic feet per second cfs. To be conservative, a 100-year flow of 1,500 cfs was assumed for the channel.

4. Hydraulic Analysis

4.1 HEC-RAS Model

4.1.1 Cross-section Interpolation

DWR provided a HEC-RAS model to use as a basis for Big Chico Creek. The cross sections in the model were widely spaced and usually were not located at the sites being studied for this project. As a result, interpolated cross sections were created through the project sites using the bounding upstream and downstream model sections. No other adjustments were made to this model.

4.1.2 Results

The hydraulic characteristics needed for the purpose of designing the erosion control measures included velocity, flow depth, and the channel slope. Table 2 provides a summary of these parameters by cross section. More detailed results can be found in Appendix B.

Table 2 – Hydraulic Results Summary

Site No.	Depth of Flow	Maximum Channel Velocity
	(ft)	(ft/s)
1	4.9	4.4
2	4.6	6.3
3	4.5	6.8
4	4.9	9.0
5	3.9	7.2
6	9.6	5.6
7	7.8	5.9
8	5.0	11.0
9	4.4	4.3
Warner St. Bridge	9.8	5.5

5. Design

The proposed erosion control measures selected for the 10 scour locations were selected based on the site conditions and site specific needs. Aesthetics was also a consideration, especially in the locations throughout Bidwell Park. Since the Park is a natural setting that is heavily used by the community, an aesthetically pleasing, natural looking erosion control solution was preferred for sites 1-5 and 8-9. For the Warner Street Bridge, aesthetics was not the deciding factor as this area is more developed and commercial. Sites 6 and 7 are located in Hooker Oak Park where the area is more developed and the banks are heavily used for recreational purposes. As a result, natural aesthetics was less of a deciding factor for these sites.

For the above reasons, gabion baskets were the proposed solution for scour at sites 1-5 and 8-9, concrete block walls were proposed for sites 6 and 7, and rock slope protection (RSP), was the proposed solution for the Warner Street Bridge (Site 10). Gabion baskets and RSP must be designed such that the proposed rock diameter can withstand the channel velocity and the shear stress associated with the creek flow.

5.1 Sites 1-5 and 8-10 Design

5.1.1 Rock Average Diameter Analysis

Based on the normal depth of flow in the creek and velocity, the minimum average diameter can be calculated. The US Army Corps of Engineers (USACOE), *Hydraulic Design of Flood Control Channels*' equation for calculating rock size is as follows:

$$D_{30} = S_f C_s C_V C_T d \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right)^{1/2} \frac{V}{\sqrt{K_1 g d}} \right]^{2.5}$$

Where:

D_{30} = riprap diameter which 30 percent is smaller than in size (in)
S_f = safety factor
C_s = stability coefficient for incipient failure
C_V = vertical velocity distribution coefficient
C_T = thickness coefficient
d = local depth of flow (ft)
γ_w = unit weight of water (lb/ft^3)
γ_s = unit weight of stone (lb/ft^3)
V = velocity (ft/s)
K_1 = side slope correction factor
g = gravitational constant (ft/s^2)

The equation for calculating the average diameter of rock is as follows:

$$D_{50} = D_{30}\left({}^{D_{85}}/_{D_{15}}\right)^{1/3}$$

For gabions, the standard design is to contain an average rock size of 6 inches. The average rock size calculations were completed to confirm if the 6-inch standard would be sufficient for each site. If the calculated rock size was less than 6 inches, it was assumed the gabion size would be increased to have an average diameter of 6 inches per standard design. The average rock size for the gabions was determined to be 6 inches and 7 inches, and the average rock size determined for the RSP at Warner Street Bridge was 12 inches. The summary table and detailed calculations for the average diameter is located in Appendix C.

5.1.2 Shear Stress Analysis

Based on the normal depth of flow in the creek and velocity, the design shear stress can be calculated. The design shear stress must be compared to the permissible shear stress the proposed rocks can withstand. The Federal Highway Administration, USACOE, *Hydraulic Engineering Circular No. 23, Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance-Third Edition*'s equation for shear stress is as follows:

$$\tau_{des} = K_b \gamma_w y S_f$$

Where:

τ_{des} = design shear stress (lb/ft^2)
K_b = bend coefficient
γ_w = unit weight of water (lb/ft^3)
y = local depth of flow (ft)
S_f = slope of channel (ft/ft)

The equation for permissible shear stress is as follows:

$$\tau_p = C_s(\gamma_s - \gamma_w)d_{50}$$

Where:

τ_p = permissible shear stress (lb/ft^2)
d_{50} = average rock diameter (ft)
C_s = stability coefficient
γ_w = unit weight of water (lb/ft^3)
γ_s = unit weight of stone (lb/ft^3)

The calculations for design and permissible shear stress are located in Appendix C. All of the proposed average diameter rock sizes are suitable for the design conditions and provide sufficient protection to withstand the design permissible shear stress at each site.

5.1.3 Results

For the erosion control to be adequately sized, it must have a minimum rock diameter that will withstand the creek velocities and also be sized to accommodate the shear stress associated with the channel. Whichever calculations, average diameter, or shear stress analysis resulted in a greater average rock diameter requirement was the size assume moving forward.

See Appendix C for the detailed analysis and summary table of rock size for the RSP and gabion baskets.

5.2 Sites 6 and 7 Design

Sites 6 and 7 will take a more hardscaped approach to the erosion control device. Sites 6 and 7 are located in Hooker Oak Park and are subject to community members using the banks of the creek to climb down and swim. Due to the common foot-traffic down the bank RSP or gabions we not considered feasible. For these reasons, a concrete block wall will be utilized for those sites.

6. Scour Depth

To determine the required depth below the ground surface to embed the concrete blocks, gabions, and toe depth of the RSP, the maximum scour depth was calculated. Per HEC-23 the maximum scour depth to embed RSP is equal to the toe scour plus contraction scour; contraction scour only applies at bridges. The contraction scour was calculated in HEC-RAS using an assumed d_{50} for the sandy loam of 0.098 millimeters. The equation for toe scour, per the HEC-23 Volume 1 equation 4.5, is:

$$D_{mxb} = D_{mnc}\left(1.8 - 0.051\left(\frac{R_c}{W}\right) + 0.0084\left(\frac{W}{D_{mnc}}\right)\right)$$

Where:

R_c = centerline radius of the bend (ft)
W = width of the creek (ft)
D_{mxb} = Maximum water depth at bend due to scour (ft)
D_{mnc} = Average water depth in channel (ft)

The calculated scour depth was used to determine the depth below the original ground the erosion control measures must be embedded to. The calculations for scour depth are located in Appendix D.

7. Conclusions & Recommendations

The Big Chico Creek Scour Repair Project is a project that will address the erosion problems along Big Chico Creek, which will ultimately protect the creek from experiencing further erosion. The repair sites are adjacent to roads or multi-purpose trails so addressing the erosion will ensure there are no further issues created and the integrity of the surrounding facilities are not compromised.

Utilizing gabions at 7 out the 10 sites will provide adequate erosion control measures that are aesthetically compatible with Bidwell Park. RSP is recommended to be used at Warner Street Bridge, and a concrete block wall is recommended to be used for sites 6 and 7. Because these sites are located in developed parks and commercial areas, aesthetics were less of a concern and as such alternative erosion control measures are the recommended approach at these sites. Sites 6 and 7 have heavy foot traffic down the banks of the creek and a more hardscaped approach was appropriate. See Table 3 for a summary of the average rock diameter required at the project sites as well as the scour depth below the original ground.

All sites can be protected from erosion with relatively small RSP that is less than 15-inches in average rock diameter. Exhibits for each of the sites showing the recommended erosion protection can be found in Appendix E.

Table 3 – Erosion Protection Summary

Site No.	D_{50} Calculated	D_{50} Proposed	Scour Depth
	(ft)	(ft)	(ft)
1	0.1	0.5	5
2	0.2	0.5	4
3	0.2	0.5	2
4	0.4	0.5	1
5	0.3	0.5	4
6	-	-	9
7	-	-	6
8	0.6	0.6	2
9	0.1	0.5	6
Warner St. Bridge	1.0	1.0	9

8. Preliminary Cost Estimates

Preliminary cost estimates were developed for the each of the 10 sites. The total cost for the scour repair measures at all locations is approximately $3.3 million, assuming the sites are constructed independently from one another. See Appendix F for a summary and a detailed breakdown of the preliminary cost estimate for each scour site.

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9. References

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United Stated Army Corps of Engineers, *Hydraulic Design of Flood Control Channels*, 1994.

United States Department of Agriculture Natural Resources Conversation Service, *Custom Soil Resource Report for Butte Area, California, Parts of Butte and Plumas Counties*, 2021.

United States Geologic Survey (USGS), *Quad Maps for Chico, CA*, 2018.

10. Appendices

Appendix A – NRCS Site Soil Resource Report

Appendix B – HEC-RAS Hydraulic Results

Appendix C – Gabion and Rock Slope Protection Analysis

Appendix D – Scour Analysis

Appendix E – Site Erosion Control Exhibits

Appendix F - Preliminary Cost Estimates

APPENDIX A

NRCS Site Soil Resource Report

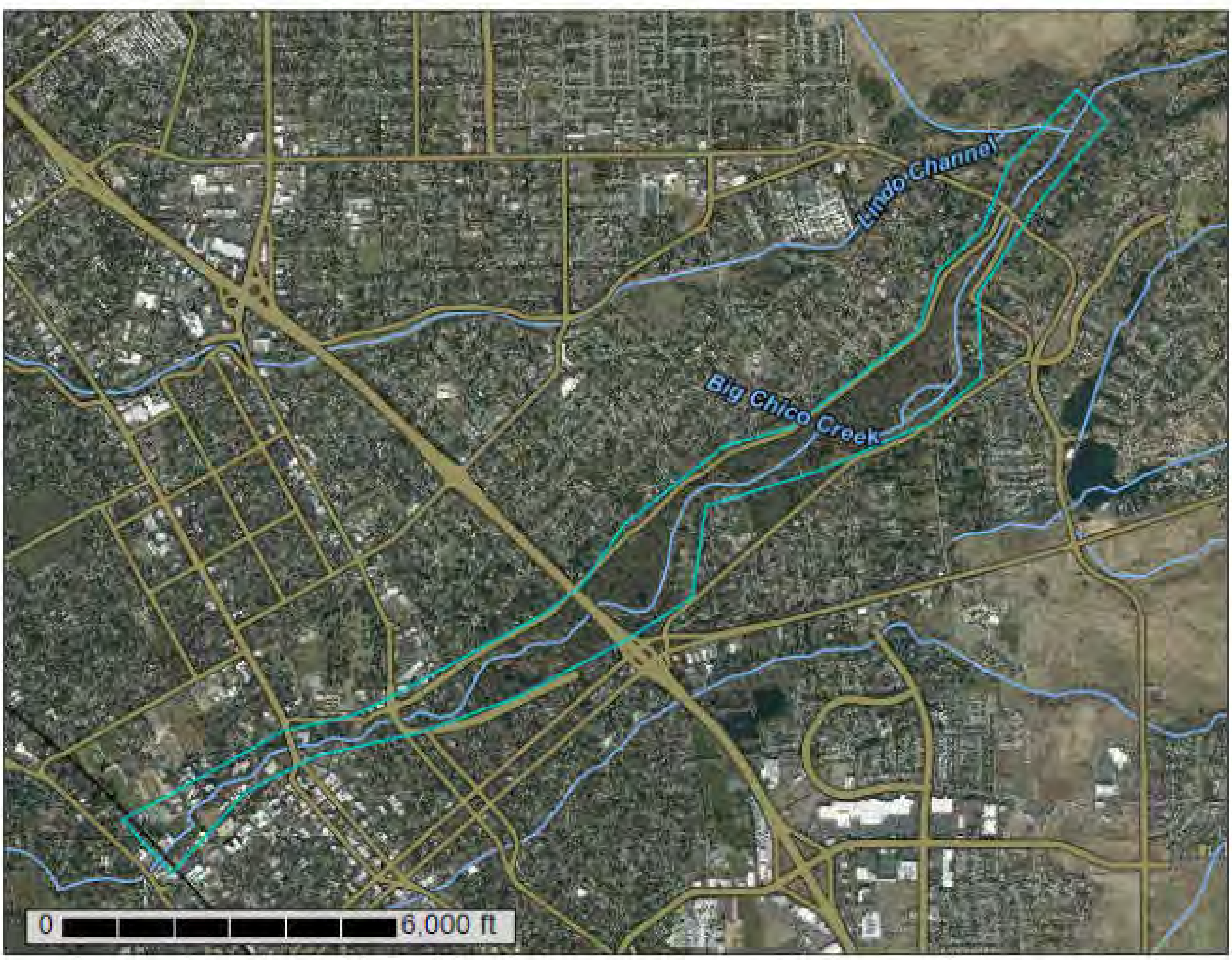
United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Butte Area, California, Parts of Butte and Plumas Counties

Big Chico Creek



December 16, 2021

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

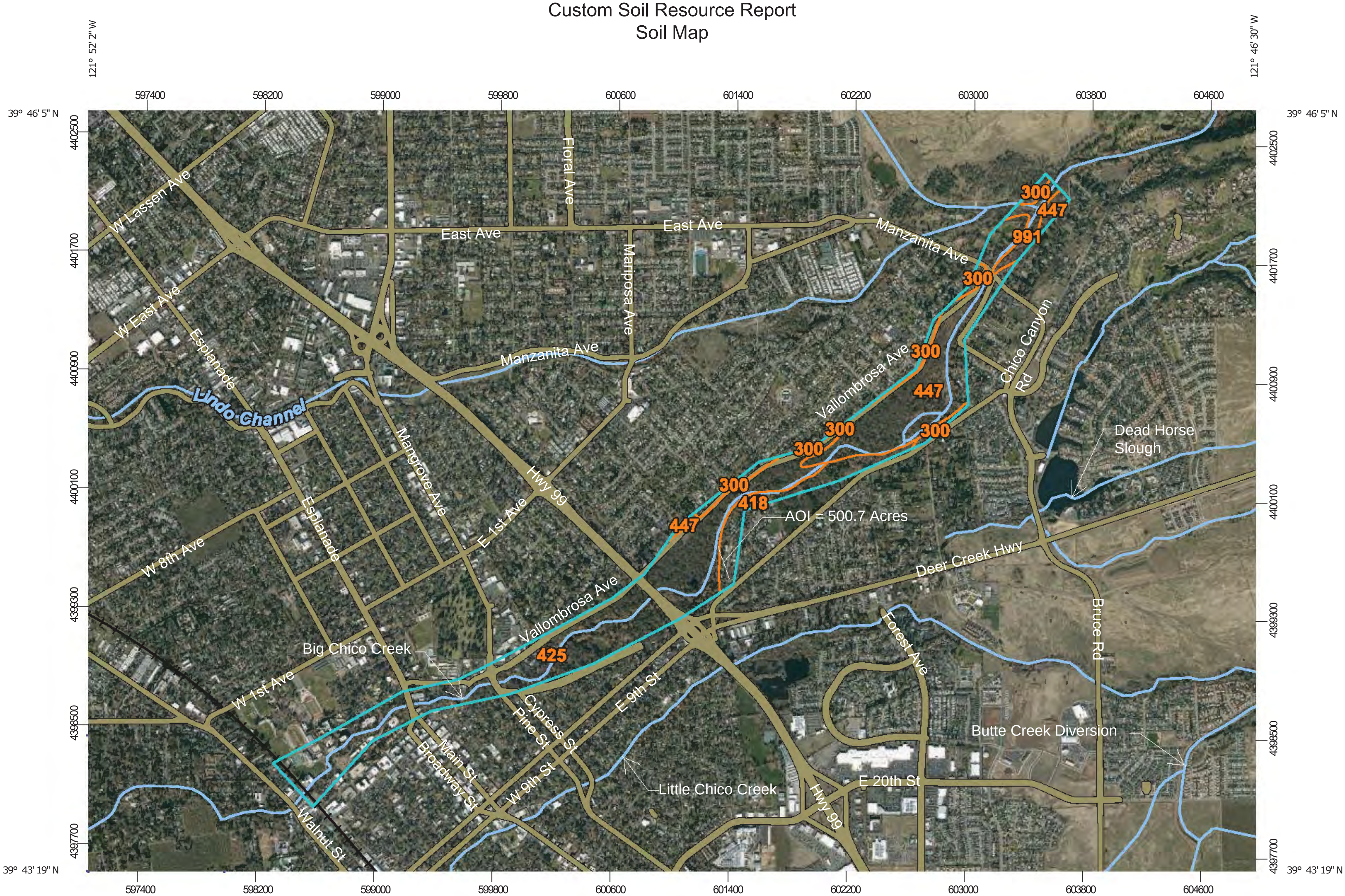
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:36,100 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 1500, 3000, 6000, 9000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Butte Area, California, Parts of Butte and Plumas Counties
Survey Area Data: Version 18, Sep 6, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 6, 2018—Dec 12, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
300	Redsluff gravelly loam, 0 to 2 percent slopes	23.6	4.7%
418	Almendra loam, 0 to 1 percent slopes	40.9	8.2%
425	Vina fine sandy loam, sandy substratum, 0 to 2 percent slopes, MLRA 17	275.9	55.1%
447	Charger fine sandy loam, 0 to 1 percent slopes	143.6	28.7%
991	Xerofluvents, 0 to 4 percent slopes frequently flooded	16.7	3.3%
Totals for Area of Interest		**500.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Butte Area, California, Parts of Butte and Plumas Counties

300—Redsluff gravelly loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: hh0t
Elevation: 180 to 400 feet
Mean annual precipitation: 24 to 29 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 250 to 255 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Redsluff, gravelly loam, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Redsluff, Gravelly Loam

Setting

Landform: Fan terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-loamy alluvium derived from igneous, metamorphic and sedimentary rock over gravelly alluvium derived from volcanic rock

Typical profile

Ap - 0 to 2 inches: gravelly loam
Bt1 - 2 to 5 inches: gravelly loam
Bt2 - 5 to 12 inches: gravelly clay loam
Bt3 - 12 to 21 inches: gravelly loam
Bt4 - 21 to 29 inches: gravelly loam
Bt5 - 29 to 37 inches: gravelly loam
Bt6 - 37 to 42 inches: extremely gravelly sandy loam
Cq - 42 to 80 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.28 to 0.99 in/hr)
Depth to water table: About 35 to 80 inches
Frequency of flooding: RareNone
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 0.5 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C

Hydric soil rating: No

Minor Components

Unnamed, weak cementation below 40 inches
Percent of map unit: 4 percent
Landform: Fan terraces
Hydric soil rating: No

Fernandez, sandy loam
Percent of map unit: 4 percent
Landform: Fan terraces
Hydric soil rating: No

Typic haploxeralfs, very deep
Percent of map unit: 3 percent
Landform: Fan terraces
Hydric soil rating: No

Anita, gravelly duripan
Percent of map unit: 3 percent
Landform: Fan terraces
Hydric soil rating: Yes

Pachic argixerolls
Percent of map unit: 2 percent
Landform: Fan terraces
Hydric soil rating: No

Redtough
Percent of map unit: 2 percent
Landform: Fan terraces
Hydric soil rating: No

Munjar
Percent of map unit: 2 percent
Landform: Fan terraces
Hydric soil rating: No

418—Almendra loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: hgwr
Elevation: 110 to 230 feet
Mean annual precipitation: 20 to 26 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 245 to 255 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Almendra, loam, and similar soils: 85 percent
Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Almendra, Loam

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

Ap1 - 0 to 4 inches: loam
Ap2 - 4 to 14 inches: loam
Bw1 - 14 to 29 inches: loam
Bw2 - 29 to 40 inches: loam
Bw3 - 40 to 52 inches: loam
Bw4 - 52 to 74 inches: fine sandy loam
Bw5 - 74 to 86 inches: fine sandy loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.83 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 3.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: B
Ecological site: R017XY905CA - Dry Alluvial Fans and Terraces
Hydric soil rating: No

Minor Components

Conejo, clay loam

Percent of map unit: 5 percent
Landform: Alluvial fans
Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

Unnamed, weak cementation below 40 inches

Percent of map unit: 3 percent
Landform: Alluvial fans
Hydric soil rating: No

Unnamed, water table 30 to 72 inches

Percent of map unit: 3 percent

Landform: Alluvial fans
Hydric soil rating: No

Vina, fine sandy loam
Percent of map unit: 2 percent
Landform: Alluvial fans
Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

Chico
Percent of map unit: 1 percent
Landform: Fan terraces
Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

Charger
Percent of map unit: 1 percent
Landform: Alluvial fans
Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

425—Vina fine sandy loam, sandy substratum, 0 to 2 percent slopes, MLRA 17

Map Unit Setting
National map unit symbol: 2w8b6
Elevation: 140 to 240 feet
Mean annual precipitation: 23 to 28 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 245 to 255 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Vina, fine sandy loam, sandy substratum, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Vina, Fine Sandy Loam, Sandy Substratum

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Coarse-loamy alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile
Ap1 - 0 to 3 inches: fine sandy loam
Ap2 - 3 to 11 inches: fine sandy loam

A1 - 11 to 23 inches: sandy loam
A2 - 23 to 37 inches: sandy loam
C1 - 37 to 50 inches: sandy loam
C2 - 50 to 54 inches: loamy coarse sand
C3 - 54 to 80 inches: coarse sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.13 to 3.68 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.2 to 1.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.4 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: A
Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

Minor Components

Almendra

Percent of map unit: 5 percent
Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

Charger

Percent of map unit: 5 percent
Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

Unnamed, water table 40 to 80 inches

Percent of map unit: 2 percent
Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Redsluff

Percent of map unit: 2 percent
Landform: Fan terraces
Down-slope shape: Linear
Across-slope shape: Linear

Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

Xerofluvents

Percent of map unit: 1 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

447—Charger fine sandy loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: hgzf
Elevation: 180 to 600 feet
Mean annual precipitation: 24 to 28 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 250 to 255 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Charger, fine sandy loam, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Charger, Fine Sandy Loam

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Coarse-loamy alluvium derived from igneous, metamorphic and sedimentary rock over gravelly alluvium derived from volcanic and metamorphic rock

Typical profile

Ap - 0 to 3 inches: fine sandy loam
A1 - 3 to 7 inches: fine sandy loam
A2 - 7 to 15 inches: fine sandy loam
Bw1 - 15 to 32 inches: sandy loam
Bw2 - 32 to 42 inches: sandy loam
Bw3 - 42 to 53 inches: sandy loam
Bw4 - 53 to 63 inches: sandy loam
C - 63 to 80 inches: extremely gravelly loamy coarse sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained

Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.27 to 4.25 in/hr)
Depth to water table: About 40 to 80 inches
Frequency of flooding: RareNone
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 0.5 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups
Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Vina, fine sandy loam
Percent of map unit: 8 percent
Landform: Alluvial fans
Hydric soil rating: No

Redsluff
Percent of map unit: 5 percent
Landform: Fan terraces
Hydric soil rating: No

Unnamed, loamy-skeletal
Percent of map unit: 2 percent
Landform: Alluvial fans
Hydric soil rating: No

Almendra
Percent of map unit: 2 percent
Landform: Alluvial fans
Hydric soil rating: No

Unnamed, sandy-skeletal
Percent of map unit: 2 percent
Landform: Alluvial fans
Hydric soil rating: No

Wafap
Percent of map unit: 1 percent
Landform: Stream terraces
Hydric soil rating: No

991—Xerofluvents, 0 to 4 percent slopes frequently flooded

Map Unit Setting
National map unit symbol: hh78
Elevation: 140 to 4,440 feet

Mean annual precipitation: 23 to 70 inches
Mean annual air temperature: 50 to 63 degrees F
Frost-free period: 110 to 260 days
Farmland classification: Not prime farmland

Map Unit Composition

Xerofluvents, sandy loam, frequently flooded, and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Xerofluvents, Sandy Loam, Frequently Flooded

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Microfeatures of landform position: Bars and channels
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified sandy and gravelly alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 6 inches: sandy loam
C1 - 6 to 14 inches: sandy loam
C2 - 14 to 26 inches: sandy loam
C3 - 26 to 37 inches: sandy loam
Ab - 37 to 43 inches: sandy loam
C4 - 43 to 47 inches: loamy sand
C5 - 47 to 54 inches: sandy loam
C6 - 54 to 72 inches: loamy sand
C7 - 72 to 80 inches: sandy loam

Properties and qualities

Slope: 0 to 4 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 28 to 80 inches
Frequency of flooding: NoneFrequentOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Xerofluvents, frequent long flooding

Percent of map unit: 13 percent
Landform: Flood plains

Microfeatures of landform position: Channels
Hydric soil rating: Yes

Charger, fine sandy loam
Percent of map unit: 6 percent
Landform: Alluvial fans
Ecological site: R017XY903CA - Stream Channels and Floodplains
Hydric soil rating: No

Vina, fine sandy loam
Percent of map unit: 3 percent
Landform: Alluvial fans
Ecological site: R017XY903CA - Stream Channels and Floodplains
Hydric soil rating: No

Xerofluvents, bedrock less than 60 inches
Percent of map unit: 3 percent
Landform: Flood plains
Microfeatures of landform position: Bars and channels
Hydric soil rating: No

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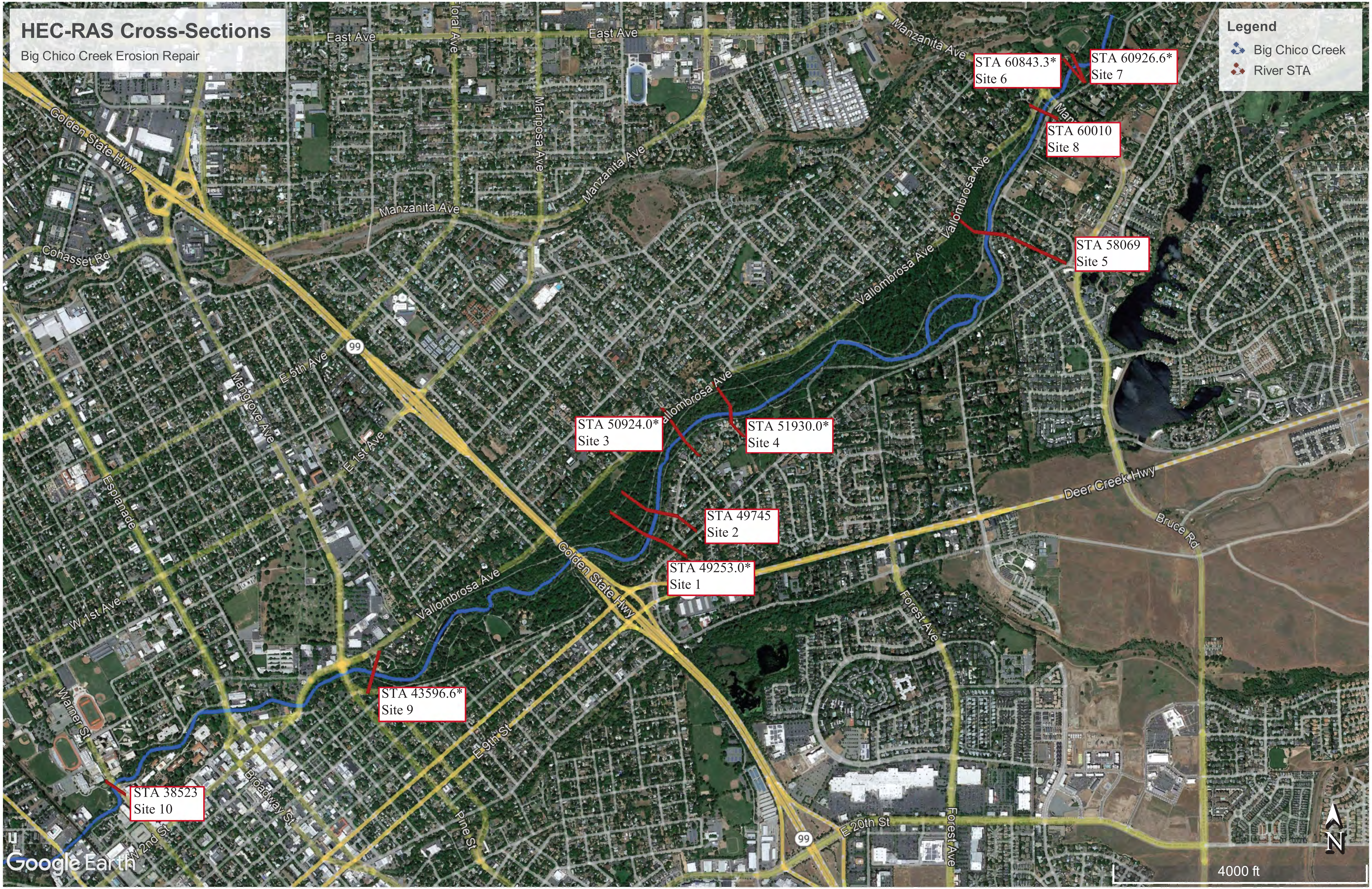
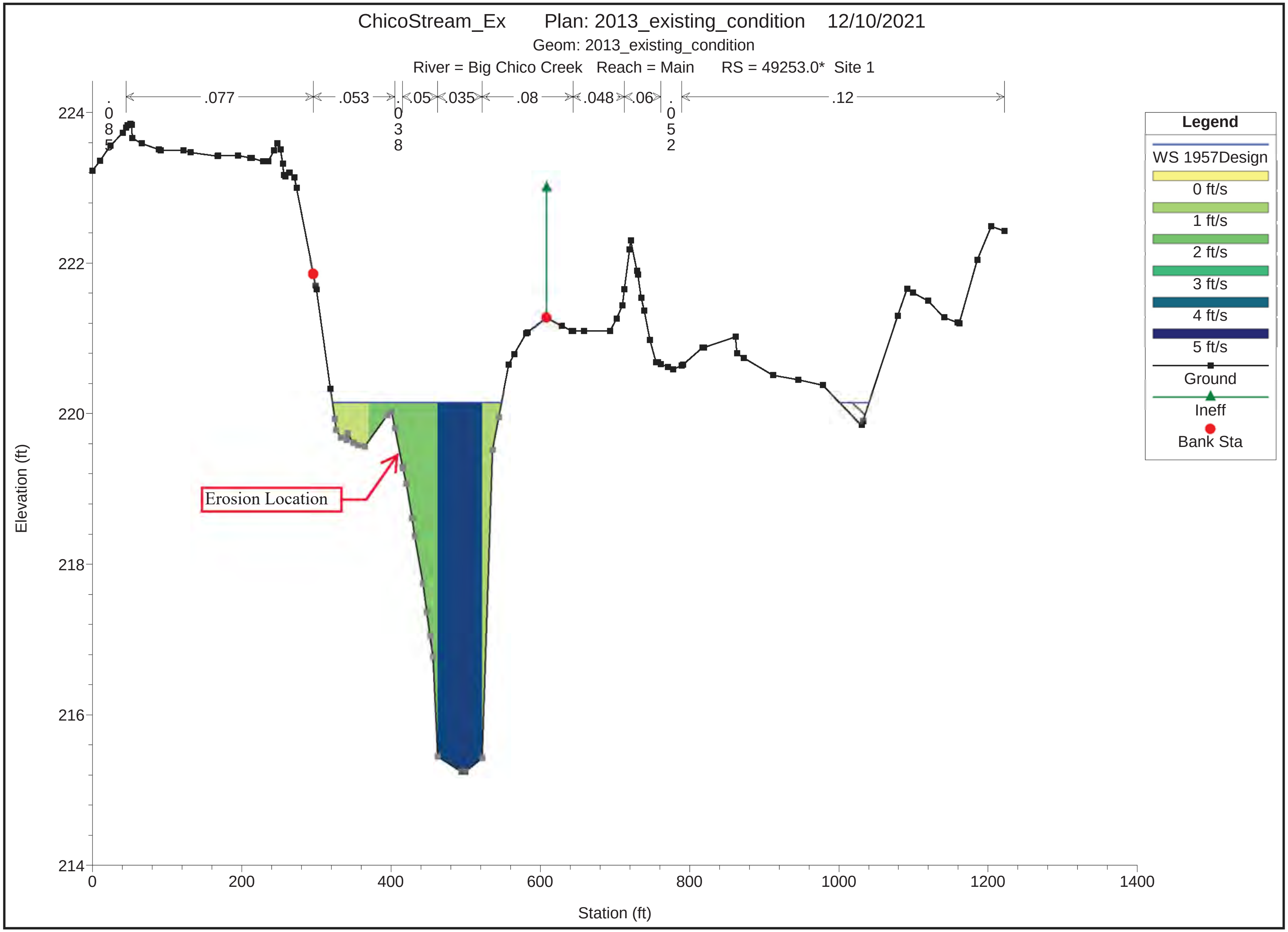
APPENDIX B

HEC-RAS Hydraulic Results



HEC-RAS Cross-Sections
Big Chico Creek Erosion Repair
Legend
Big Chico Creek
River STA
STA 60843.3* Site 6
STA 60926.6* Site 7
STA 60010 Site 8
STA 58069 Site 5
STA 50924.0* Site 3
STA 51930.0* Site 4
STA 49745 Site 2
STA 49253.0* Site 1
STA 43596.6* Site 9
STA 38523 Site 10
East Ave
Manzanita Ave
Vallombrosa Ave
Golden State Hwy
Cohasset Rd
E 5th Ave
E 1st Ave
Esplanade
W 1st Ave
Warner St
Broadway St
Pine St
E 9th St
Deer Creek Hwy
Bruce Rd
Forest Ave
E 20th St
Mariposa Ave
99
4000 ft
N
Google Earth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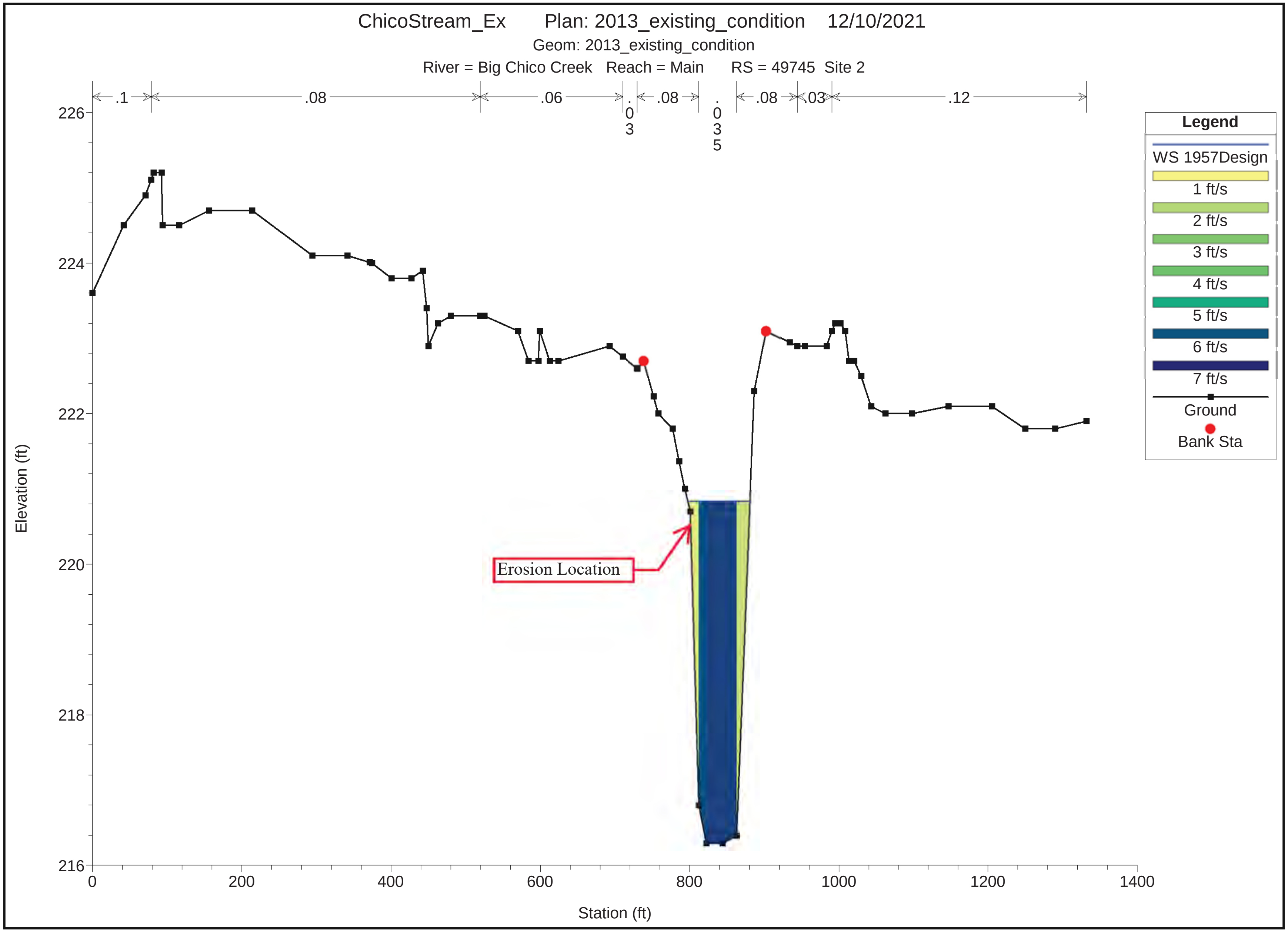
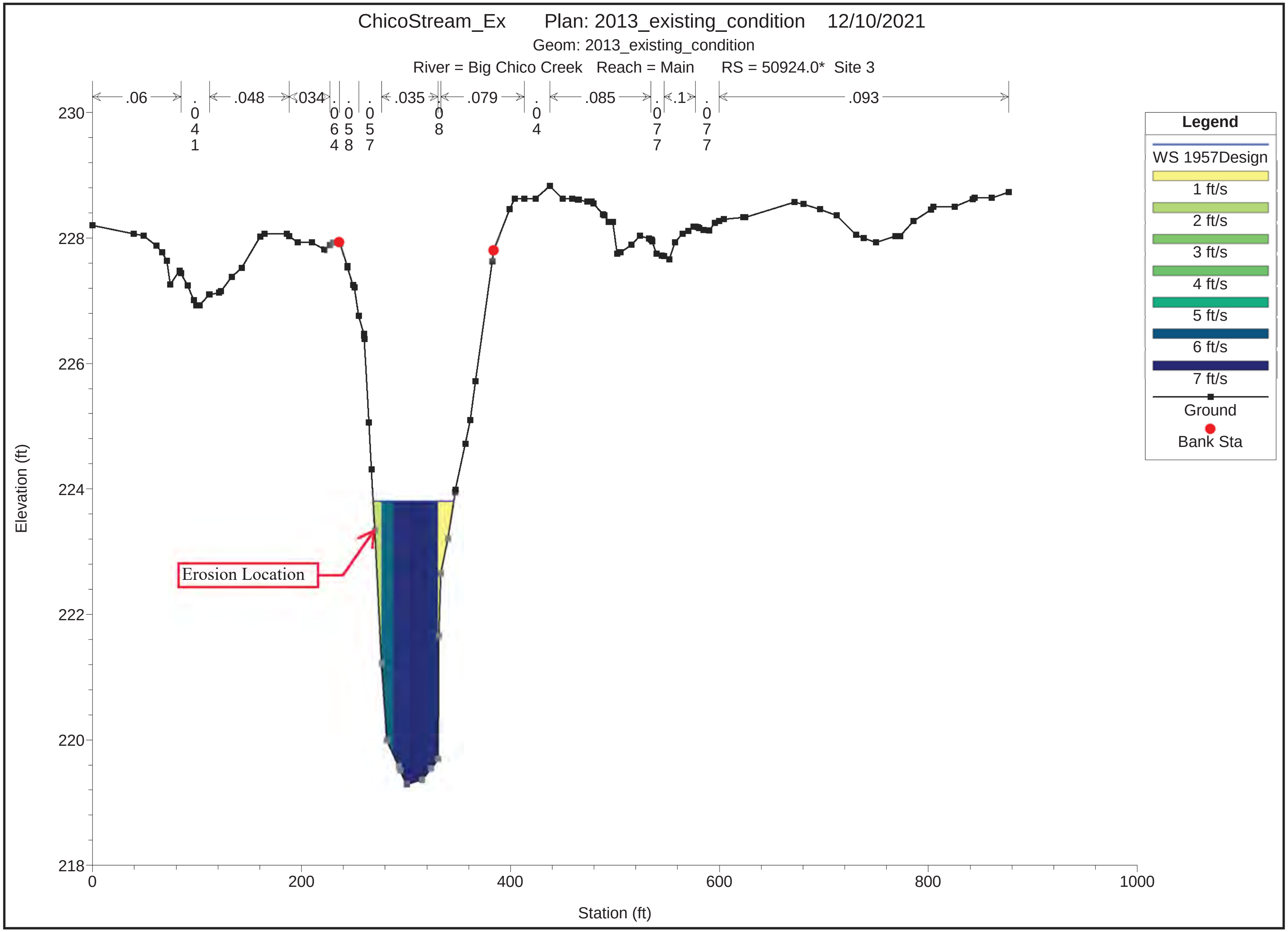
Geom: 2013_existing_condition
River = Big Chico Creek Reach = Main RS = 49253.0* Site 1
.085
.077
.053
.038
.05
.035
.08
.048
.06
.052
.12
Erosion Location
Elevation (ft)
Station (ft)
224
222
220
218
216
214
0
200
400
600
800
1000
1200
1400
Legend
WS 1957Design
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Ineff
Bank Sta



ChicoStream_Ex Plan: 2013_existing_condition 12/10/2021
Geom: 2013_existing_condition
River = Big Chico Creek Reach = Main RS = 49745 Site 2
.1
.08
.06
.03
.08
.035
.08
.03
.12
Legend
WS 1957Design
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Erosion Location
Elevation (ft)
Station (ft)
226
224
222
220
218
216
0
200
400
600
800
1000
1200
1400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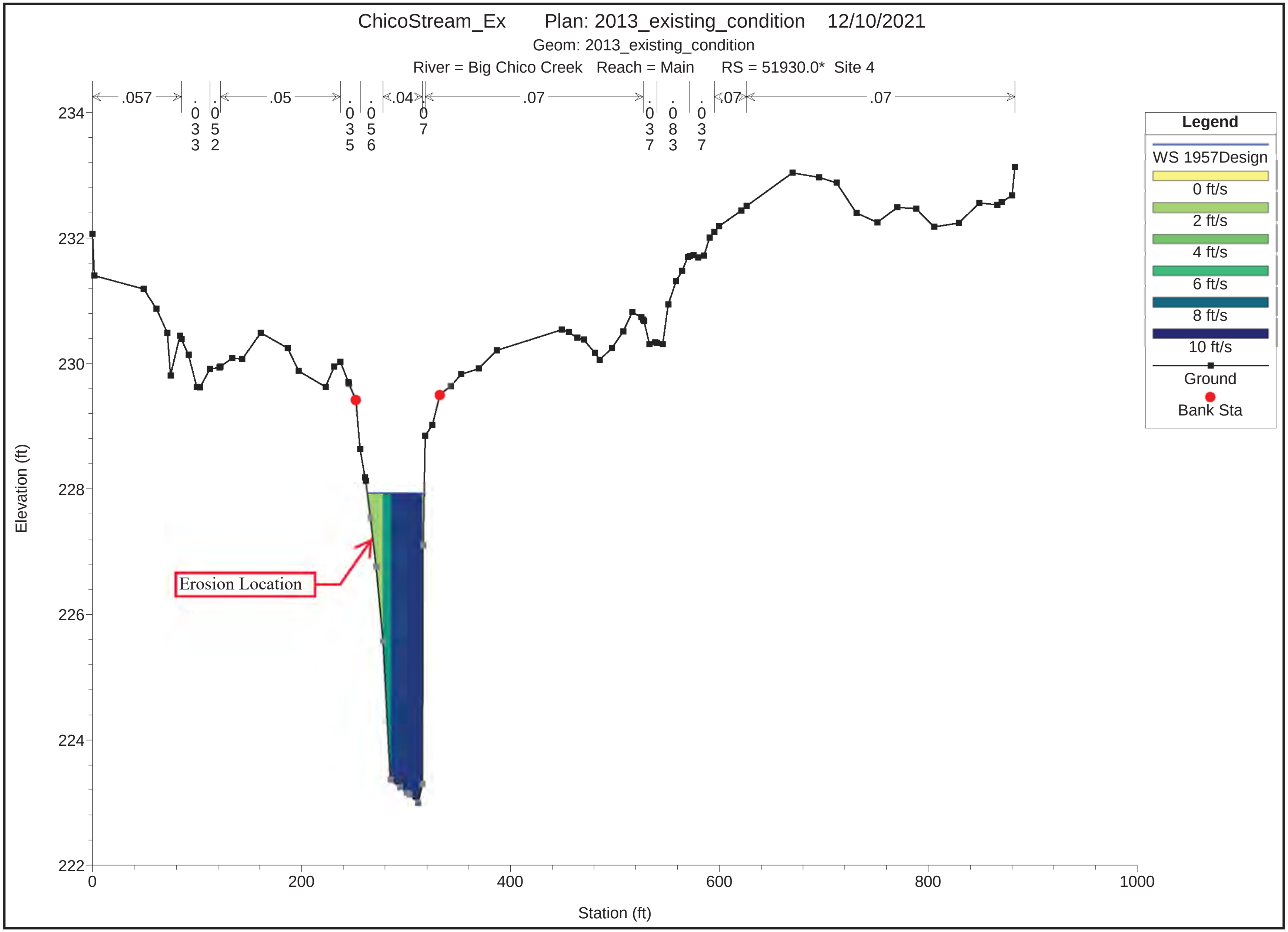
Geom: 2013_existing_condition
River = Big Chico Creek Reach = Main RS = 50924.0* Site 3
.06
.041
.048
.034
.064
.058
.057
.035
.08
.079
.04
.085
.077
.1
.077
.093
Legend
WS 1957Design
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Erosion Location
Elevation (ft)
230
228
226
224
222
220
218
0
200
400
600
800
1000
Station (ft)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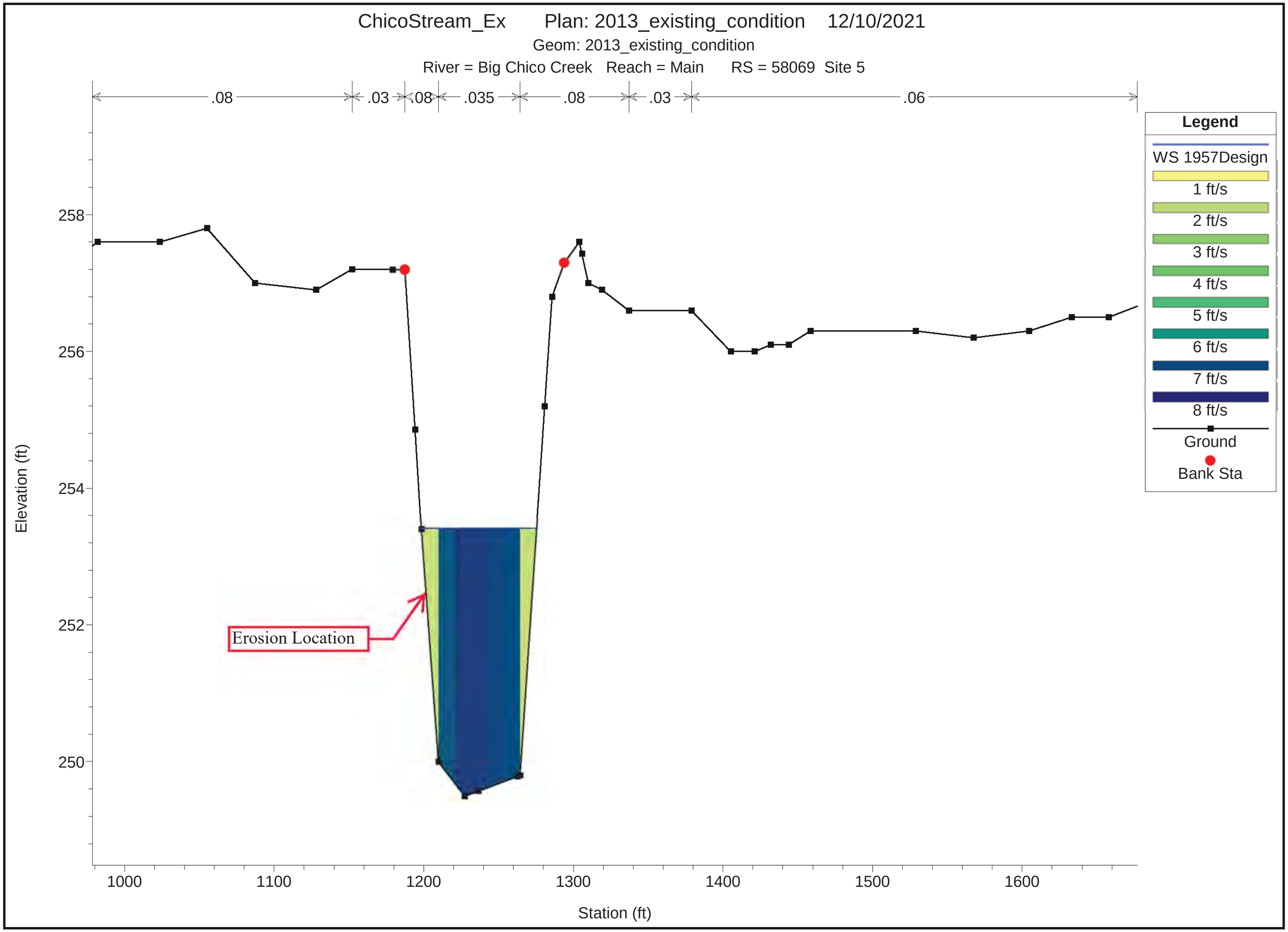
Geom: 2013_existing_condition
River = Big Chico Creek Reach = Main RS = 51930.0* Site 4
.057
.05
.04
.07
.07
.07
Legend
WS 1957Design
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Erosion Location
Elevation (ft)
Station (ft)
234
232
230
228
226
224
222
0
200
400
600
800
1000



ChicoStream_Ex Plan: 2013_existing_condition 12/10/2021
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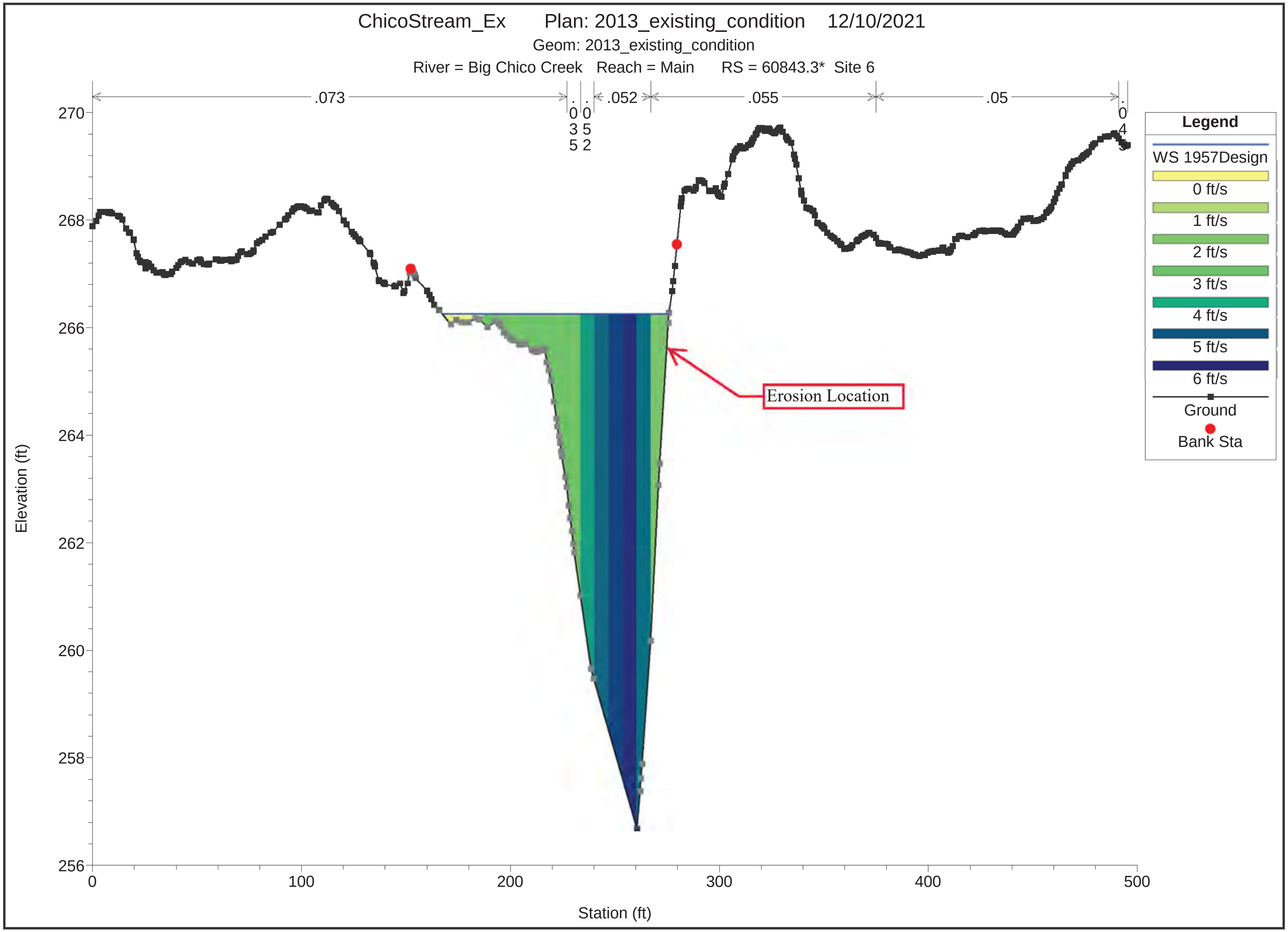
River = Big Chico Creek Reach = Main RS = 58069 Site 5
.08
.03
.08
.035
.08
.03
.06
Legend
WS 1957Design
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta
Erosion Location
Elevation (ft)
258
256
254
252
250
1000
1100
1200
1300
1400
1500
1600
Station (ft)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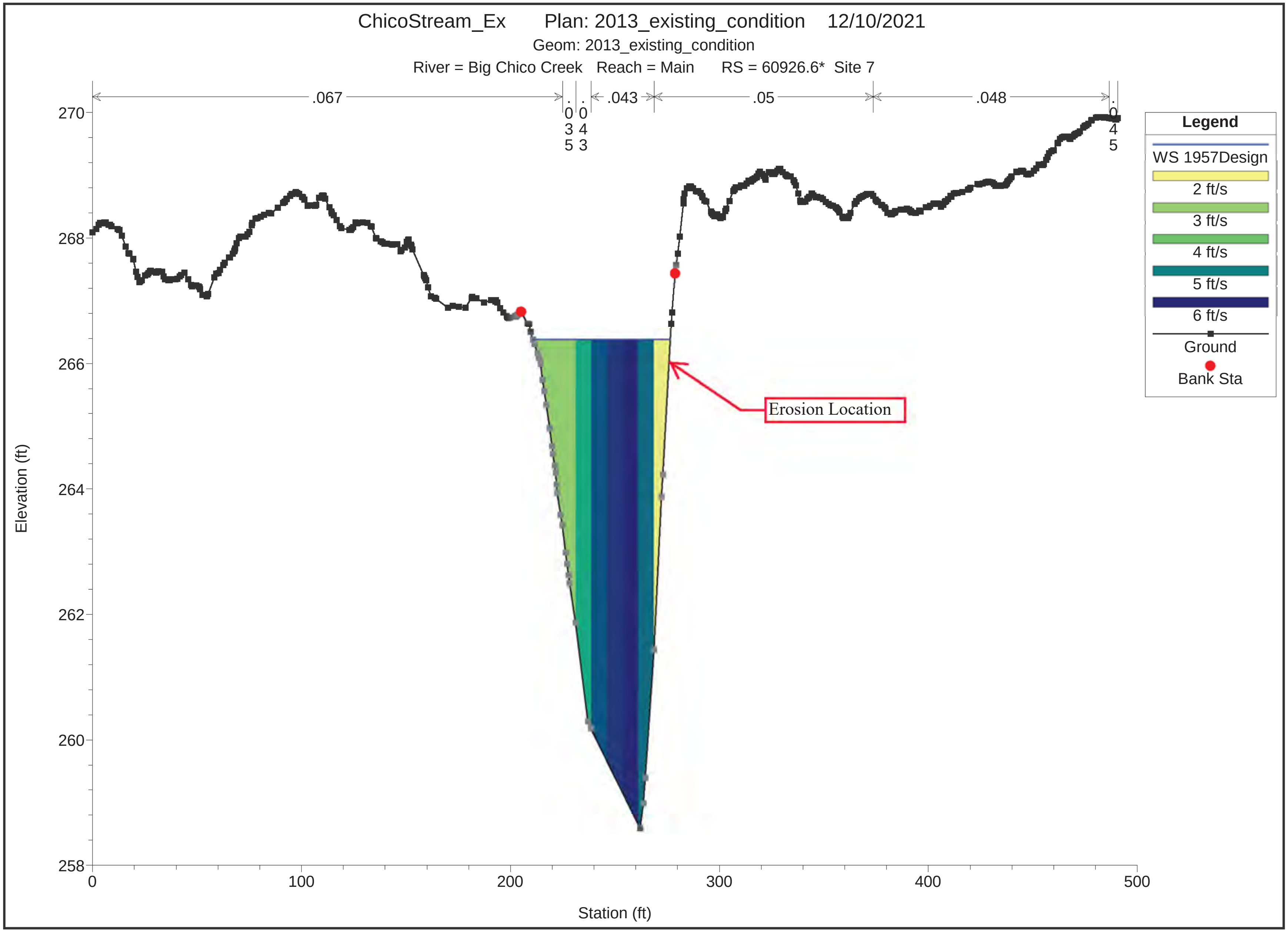
Geom: 2013_existing_condition
River = Big Chico Creek Reach = Main RS = 60843.3* Site 6
.073
.035
.052
.052
.055
.05
.043
Legend
WS 1957Design
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta
Erosion Location
Elevation (ft)
270
268
266
264
262
260
258
256
0
100
200
300
400
500
Station (ft)



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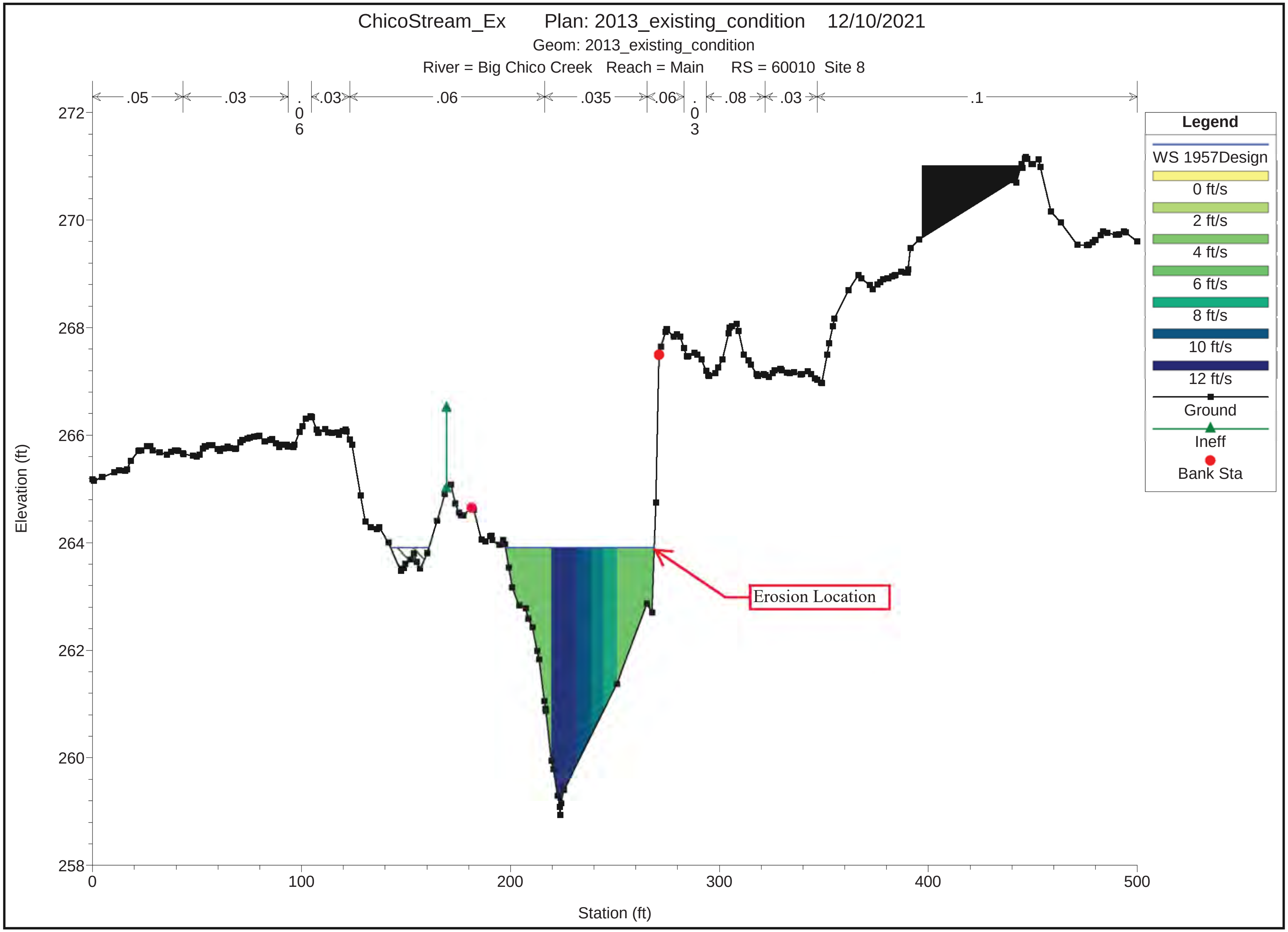
.067
.035
.043
.043
.05
.048
.045
Elevation (ft)
Station (ft)
270
268
266
264
262
260
258
0
100
200
300
400
500
Erosion Location
Legend
WS 1957Design
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta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Geom: 2013_existing_condition
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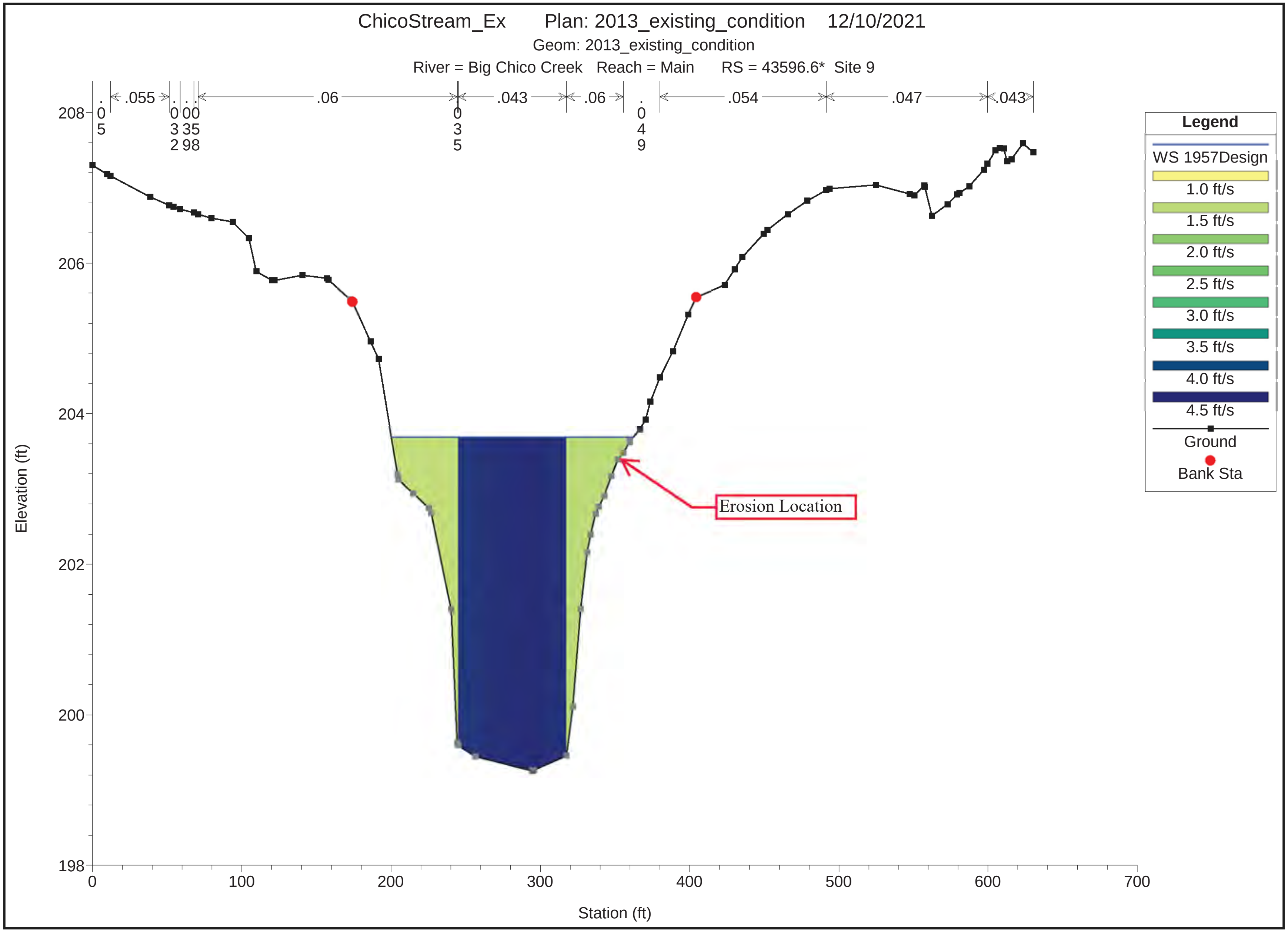
.05
.03
.06
.03
.06
.035
.06
.03
.08
.03
.1
Legend
WS 1957Design
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta
Erosion Location
Elevation (ft)
Station (ft)
258
260
262
264
266
268
270
272
0
100
200
300
400
500



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.055
.06
.043
.06
.054
.047
.043
Legend
WS 1957Design
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
Ground
Bank Sta
Erosion Location
Elevation (ft)
Station (ft)
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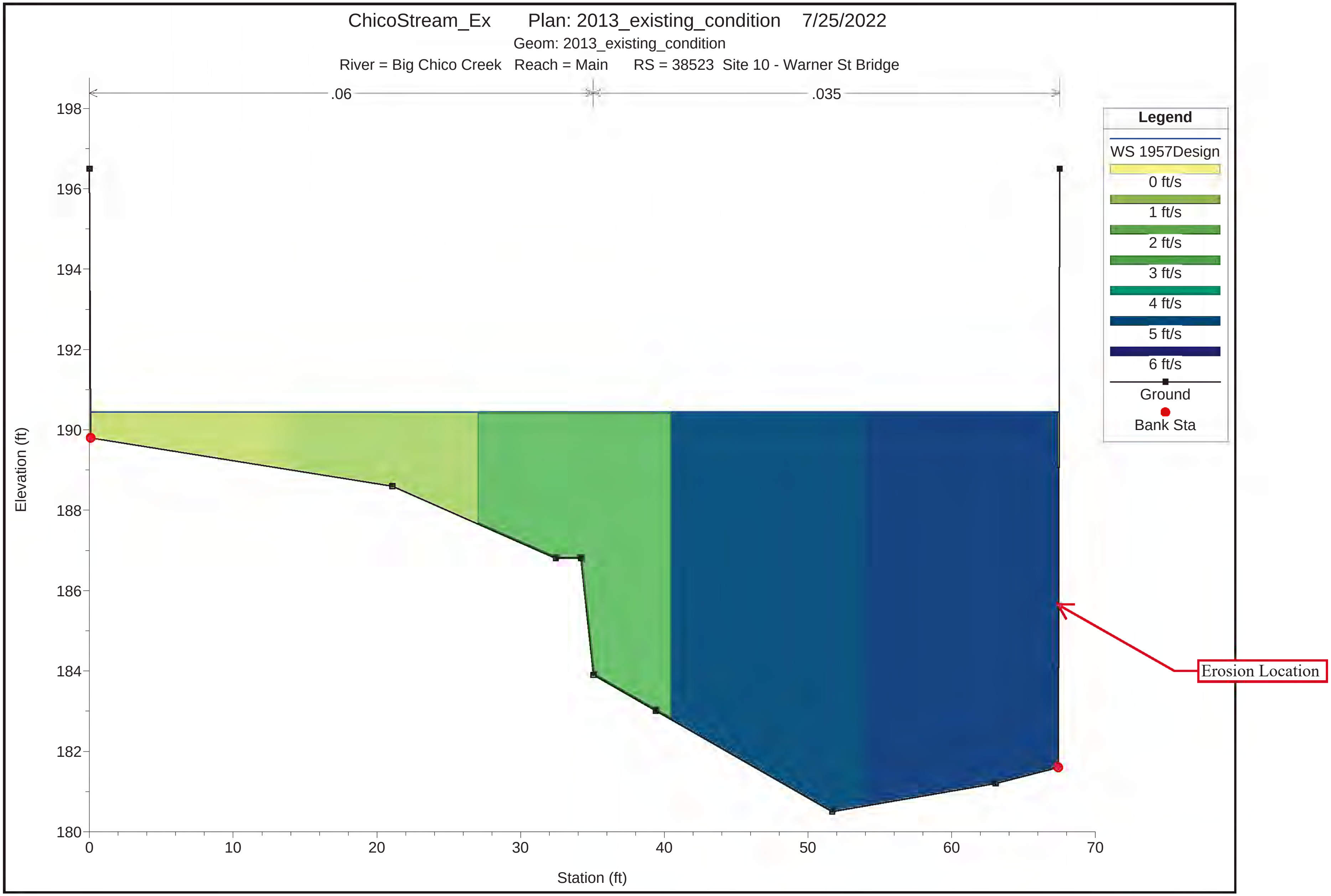
206
204
202
200
198
0
100
200
300
400
500
600
700



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Geom: 2013_existing_condition
River = Big Chico Creek Reach = Main RS = 38523 Site 10 - Warner St Bridge
.06
.035
Legend
WS 1957Design
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta
Elevation (ft)
198
196
194
192
190
188
186
184
182
180
0
10
20
30
40
50
60
70
Station (ft)
Erosion Location

Big Chico Creek HEC-RAS Results

Corresponding Site No.	River Sta		Q Total	Channel Bottom Elevation	Water Surface Elevation	Depth of Flow	Average Channel Velocity	Maximum Velocity**	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft/s)	(sq ft)	(ft)
Site 1	49253.0*		1500	215.25	220.15	4.9	3.0	4.4	479.85	265.18
Site 2	49745	4360 (FIS XS)	1500	216.3	220.86	4.6	5.1	6.3	292.13	84.08
Site 3	50924.0*		1500	219.3	223.81	4.5	5.4	6.8	249.58	76.96
Site 4	51930.0*		1500	223	227.94	4.9	7.0	9.0	188.64	54.4
Site 5	58069	4490 (FIS XS)	1500	249.5	253.42	3.9	5.1	7.2	243.28	77.15
Site 6	60843.3*		1500	256.69	266.26	9.6	4.3	5.6	348.06	108.31
Site 7	60926.6*		1500	258.6	266.38	7.8	4.7	5.9	308.27	65.73
Site 8	60010		1500	258.94	263.91	5.0	6.6	11.0	180.42	89.28
Site 9	43596.6*		1500	199.26	203.69	4.4	3.5	4.3	427.32	162.02
Warner St. Bridge	38523	3065 (FIS XS)	1500	180.5	190.31	9.8	4.3	5.5	344.74	67.4
	38484	3050 (FIS XS)	1500	180.5	190.26	9.8	4.2	5.5	341.33	67.4

*Cross section was interpolated.

**Maximum velocity was used in the erosion control design calculations

APPENDIX C

Gabion and Rock Slope Protection Analysis

Big Chico Creek Rock Size
Summary Table

Corresponding Site No.	D_{50} (in)	T_{des} (lb/ft^2)	T_p (lb/ft^2)
1	6	0.44	4.38
2	6	0.85	4.38
3	6	0.94	4.38
4	6	2.36	4.38
5	6	2.31	4.38
8	7	3.23	5.11
9	6	0.74	4.38
Warner St. Bridge	12	0.54	8.76

Rock Average Diameter Calculations

Corresponding Site No.	d (ft)	V (ft/s)	Radius of Curve, R (ft)	Width of Channel, W (ft)	R/W	C_v*	Channel Side Slope (H:V)	K_1	D_{30} (ft)	D_{50} Calculated (ft)	D_{50} Proposed (in)
1	4.9	4.4	2900	320	9.1	1.1	5	0.95	0.04	0.06	6
2	4.6	6.3	1700	200	8.5	1.1	5	0.95	0.10	0.14	6
3	4.5	6.8	2600	160	16.3	1.1	3	0.87	0.14	0.20	6
4	4.9	9.0	2000	120	16.7	1.1	4	0.93	0.25	0.36	6
5	3.9	7.2	390	100	3.9	1.2	4	0.93	0.16	0.24	6
8	5.0	11.0	490	50	9.8	1.1	7	0.99	0.39	0.56	7
9	4.4	4.3	3000	390	7.7	1.2	6	0.97	0.04	0.06	6
Warner St. Bridge	9.8	5.5	175	70	2.5	1.3	1	0.45	0.66	0.96	12

*Cv = 1.283 - 0.2log(R/W)

Constants:	S_f	**C_s****	C_T	D_{85}/D_{15}	γ_w (lb/ft^3)	γ_s (lb/ft^3)	g (ft/s^2)
	1.5	0.1	1.0	3.0	62.4	150	32.2

**A Cs value of 0.375 was used for Warner Street Bridge because gabions were not used for this location.

Shear Stress

Corresponding Site No.	y (ft)	R/W	K_b*	S_f (ft/ft)	T_{des} (lb/ft^2)
1	4.9	9.1	1.11	0.001	0.44
2	4.56	8.5	1.05	0.003	0.85
3	4.51	16.3	0.96	0.003	0.94
4	4.94	16.7	1.05	0.007	2.36
5	3.92	3.9	2.00	0.005	2.31
8	4.97	9.8	1.06	0.010	3.23
9	4.43	7.7	1.23	0.002	0.74
Warner St. Bridge	9.76	2.5	1.05	0.001	0.54

*K_b=2.38-0.206(R/W)+0.0073(R/W)^2

Constants:	γ (lb/ft^3)
	62.4

Allowable Shear Stress

Corresponding Site No.	D_{50} Proposed	Tp
	(in)	(lb/ft2)
1-5, 9	6	4.38
8	7	5.11
Warner St. Bridge	12	8.76

Constants:	C_s*	γ_w (lb/ft^3)	γ_s (lb/ft^3)
	0.10	62.4	150

*A Cs value of 0.375 was used for Warner Street Bridge, because gabions were not used for this location.

APPENDIX D

Scour Analysis

Maximum Scour Depth Summary

Corresponding Site No.	Contraction Scour Depth* (ft)	Toe Scour (ft)	Maximum Scour Depth (ft)
1	-	5	5
2	-	4	4
3	-	2	2
4	-	1	1
5	-	4	4
6	-	9	9
7	-	6	6
8	-	2	2
9	-	6	6
Warner St. Bridge	1	8	9

*Contraction scour applicable at bridges. Contraction scour depth calculated in HEC-RAS with a D_{50} of the sandy loam soil assumed to be 0.098 mm

Toe Scour Calculation

Corresponding Site No.	Centerline Radius Bend	Width of Creek Bend	Water Depth	Water Depth due to Scour	Toe Scour Depth Below Orignial Ground Surface
	(ft)	(ft)	(ft)	(ft)	(ft)
1	2900	320	4.90	9.2	4.3
2	1700	200	4.56	7.9	3.4
3	2600	160	4.51	5.7	1.2
4	2000	120	4.94	5.7	0.8
5	390	100	3.92	7.1	3.2
6	300	175	9.57	17.9	8.3
7	300	100	7.78	13.7	5.9
8	490	50	4.97	6.9	1.9
9	3000	390	4.43	9.5	5.1
Warner St. Bridge	175	70	9.76	16.9	7.2

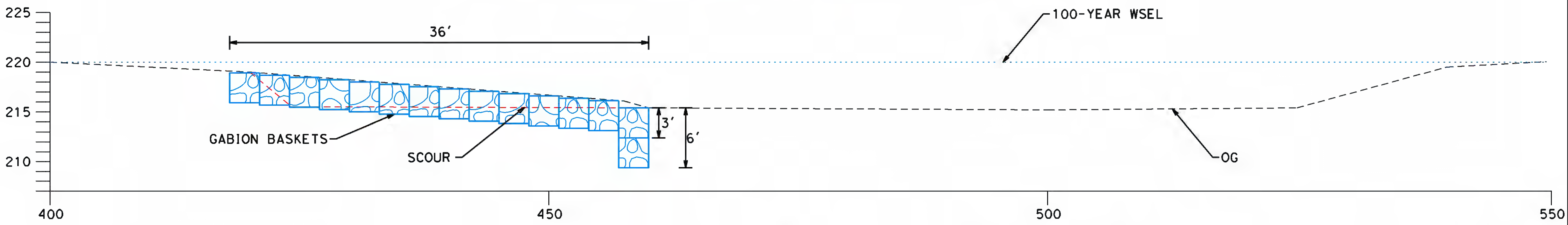
APPENDIX E

Site Erosion Control Exhibits

NOTE:
1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.

PLAN

SCALE: 1"=20'



SECTION A-A

SCALE: 1"=5'

DOKKEN ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630
(916) 858-0642

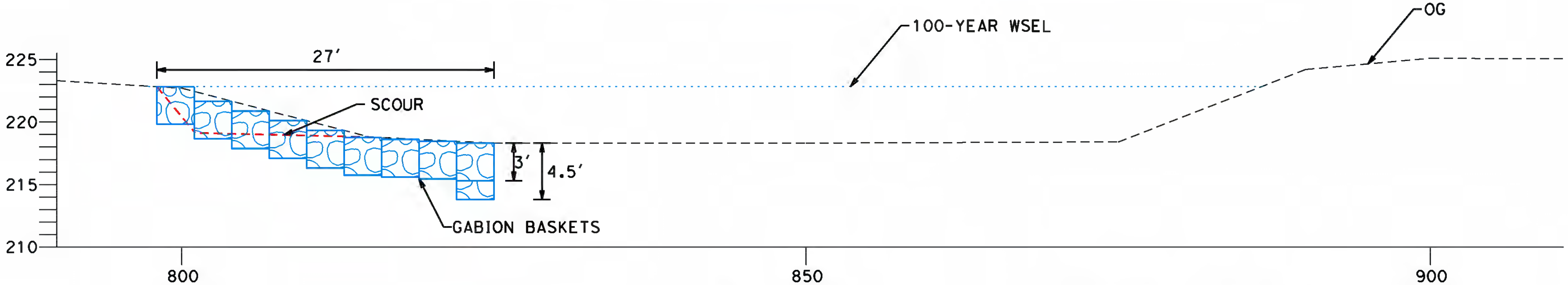
SITE 1 EROSION CONTROL EXHIBIT

BIG CHICO CREEK EROSION REPAIR

NOTE:
1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.

PLAN

SCALE: 1"=20'



SECTION A-A

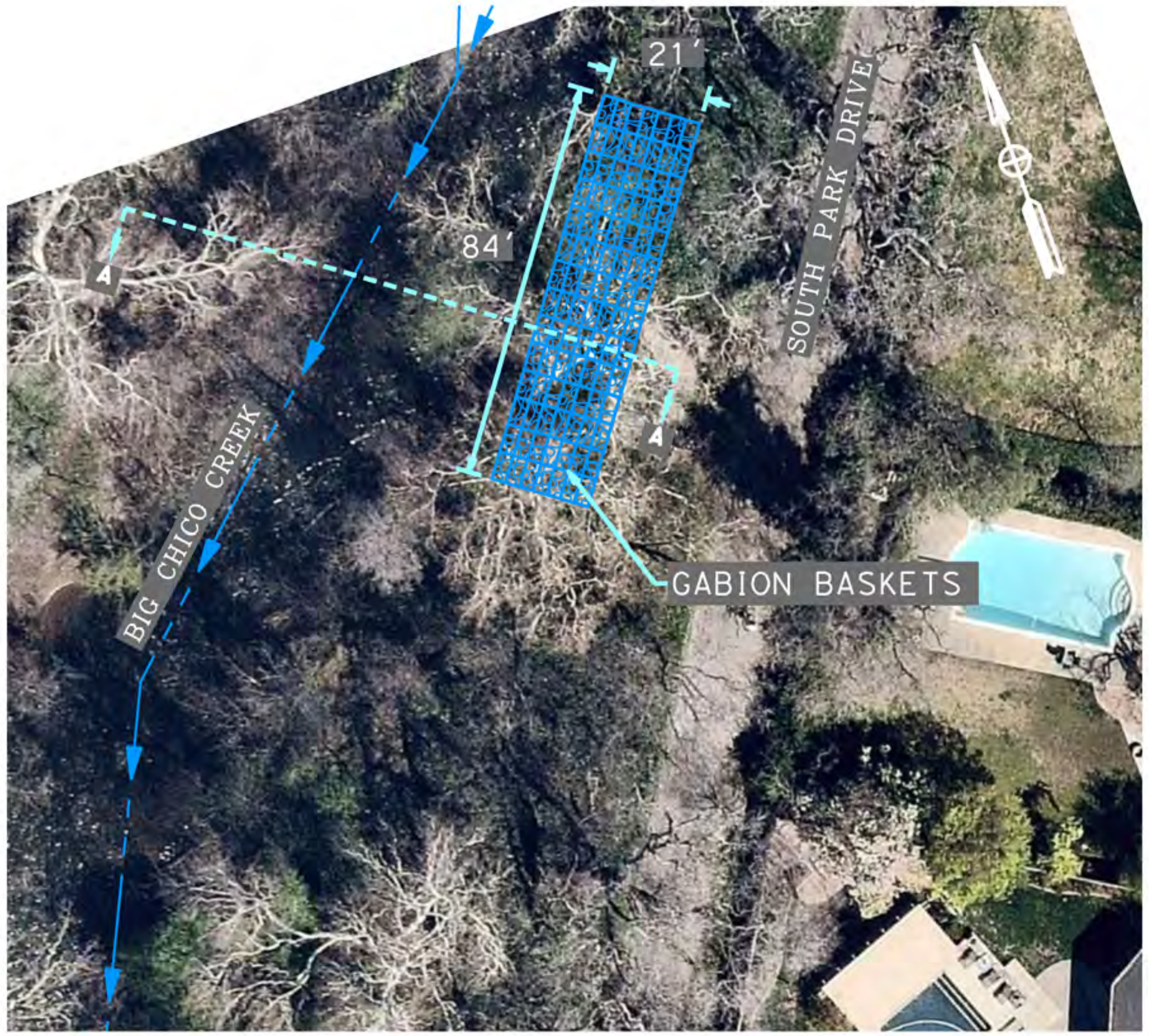
SCALE: 1"=5'

DOKKEN ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630
(916) 858-0642

SITE 2 EROSION CONTROL EXHIBIT

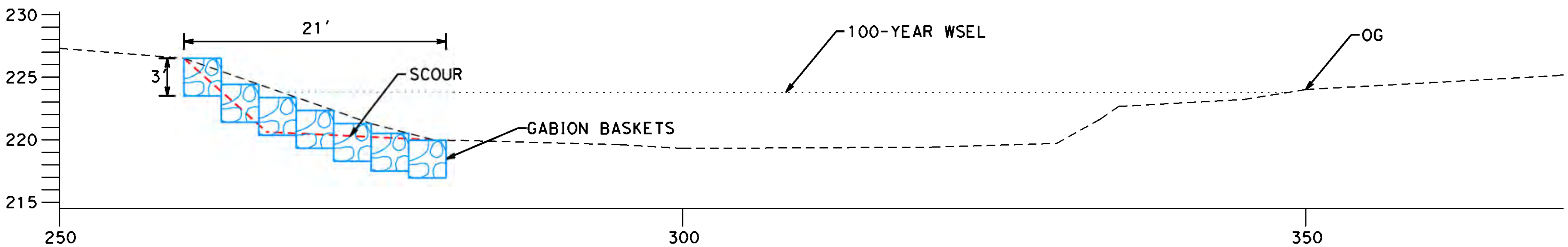
BIG CHICO CREEK EROSION REPAIR

NOTE:
1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.



PLAN

SCALE: 1"=20'



SECTION A-A

SCALE: 1"=5'

DOKKEN ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630
(916) 858-0642

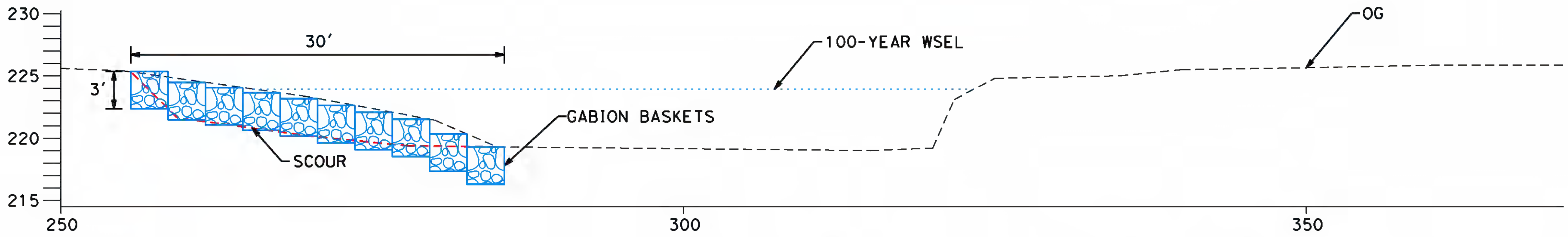
SITE 3 EROSION CONTROL EXHIBIT

BIG CHICO CREEK EROSION REPAIR

NOTE:
1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.

PLAN

SCALE: 1"=20'



SECTION A-A

SCALE: 1"=5'

DOKKEN ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630
(916) 858-0642

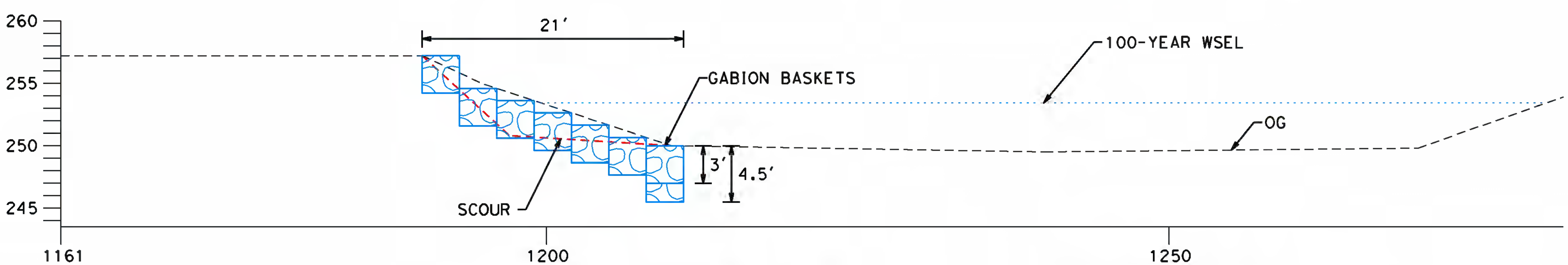
SITE 4 EROSION CONTROL EXHIBIT

BIG CHICO CREEK EROSION REPAIR

NOTE:
1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.

PLAN

SCALE: 1"=20'



SECTION A-A

SCALE: 1"=5'

DOKKEN ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630
(916) 858-0642

SITE 5 EROSION CONTROL EXHIBIT

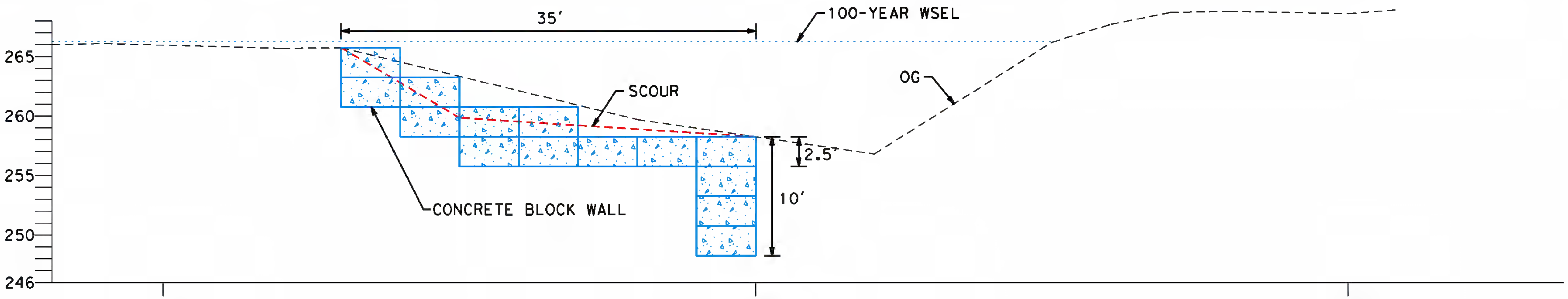
BIG CHICO CREEK EROSION REPAIR

SITE #6 PLAN

SCALE: 1"=20'

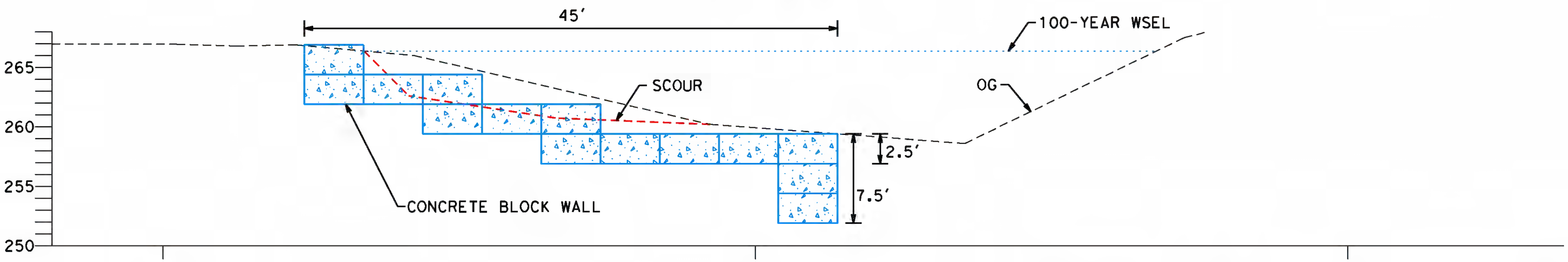
SITE #7 PLAN

SCALE: 1"=20'



SECTION A-A

SCALE: 1"=5'



SECTION B-B

SCALE: 1"=5'

NOTE:

1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.

DOKKEN
ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630
(916) 858-0642

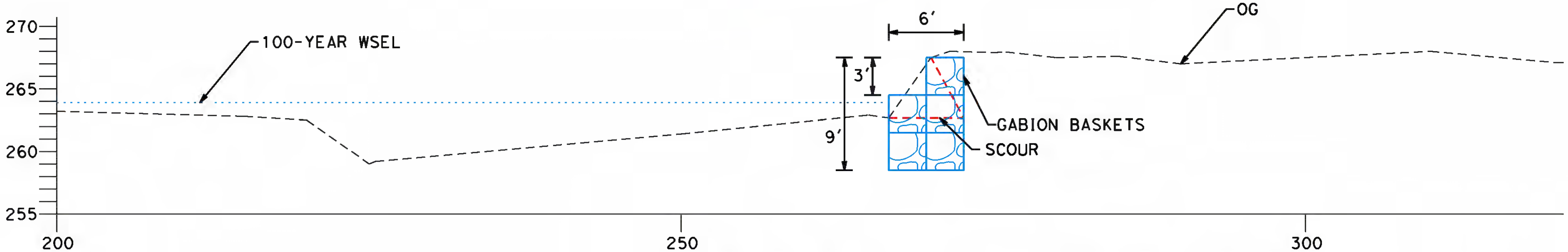
SITES 6&7 EROSION CONTROL EXHIBIT

BIG CHICO CREEK EROSION REPAIR

NOTE:
1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.

PLAN

SCALE: 1"=20'



SECTION A-A

SCALE: 1"=5'

DOKKEN ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630
(916) 858-0642

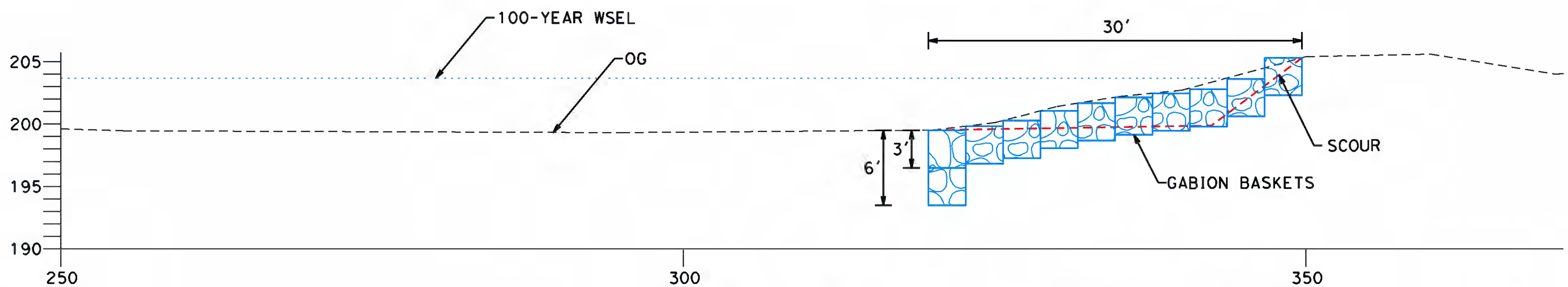
SITE 8 EROSION CONTROL EXHIBIT

BIG CHICO CREEK EROSION REPAIR

NOTE:
1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.

PLAN

SCALE: 1"=20'



SECTION A-A

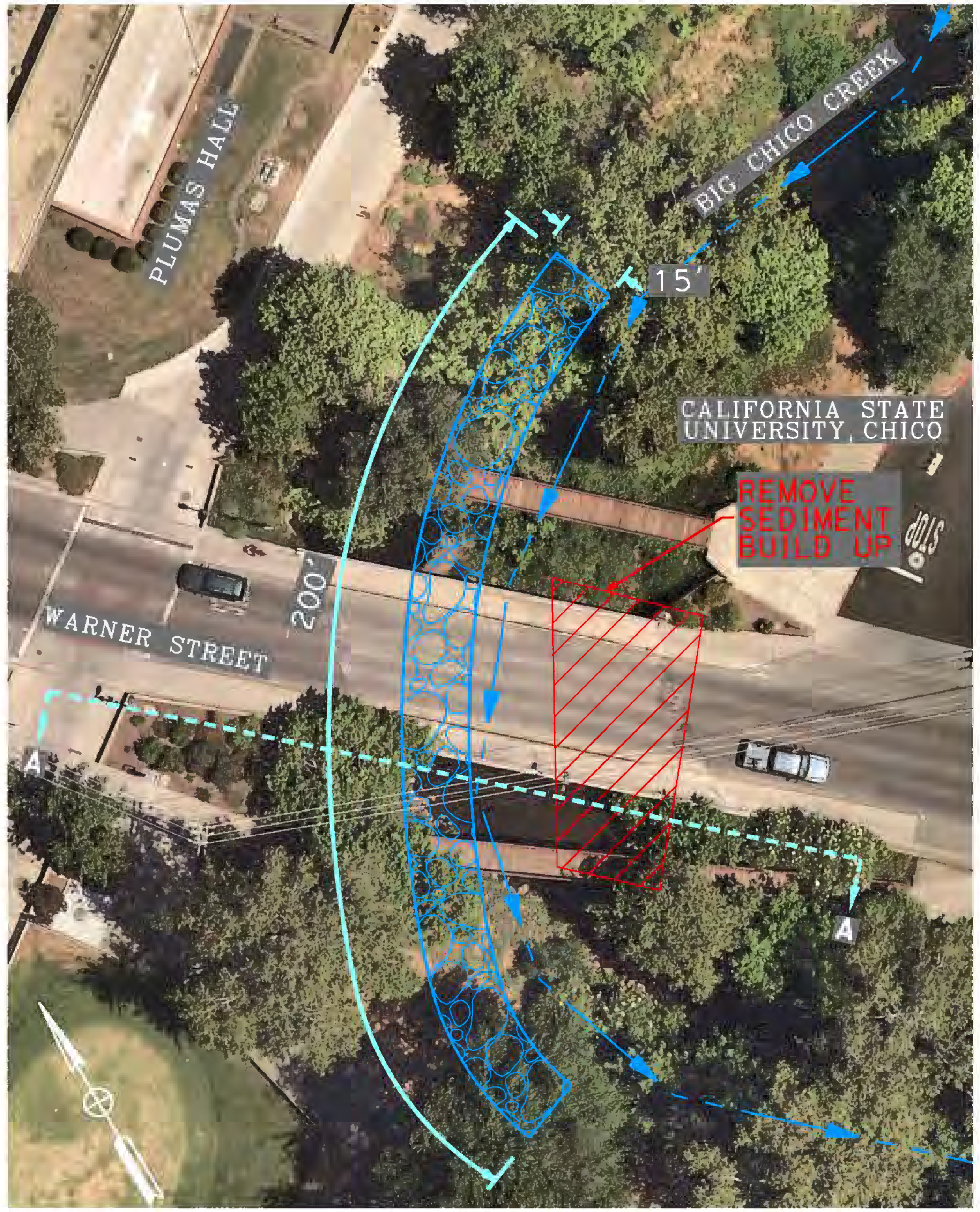
SCALE: 1"=5'

DOKKEN ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630
(916) 858-0642

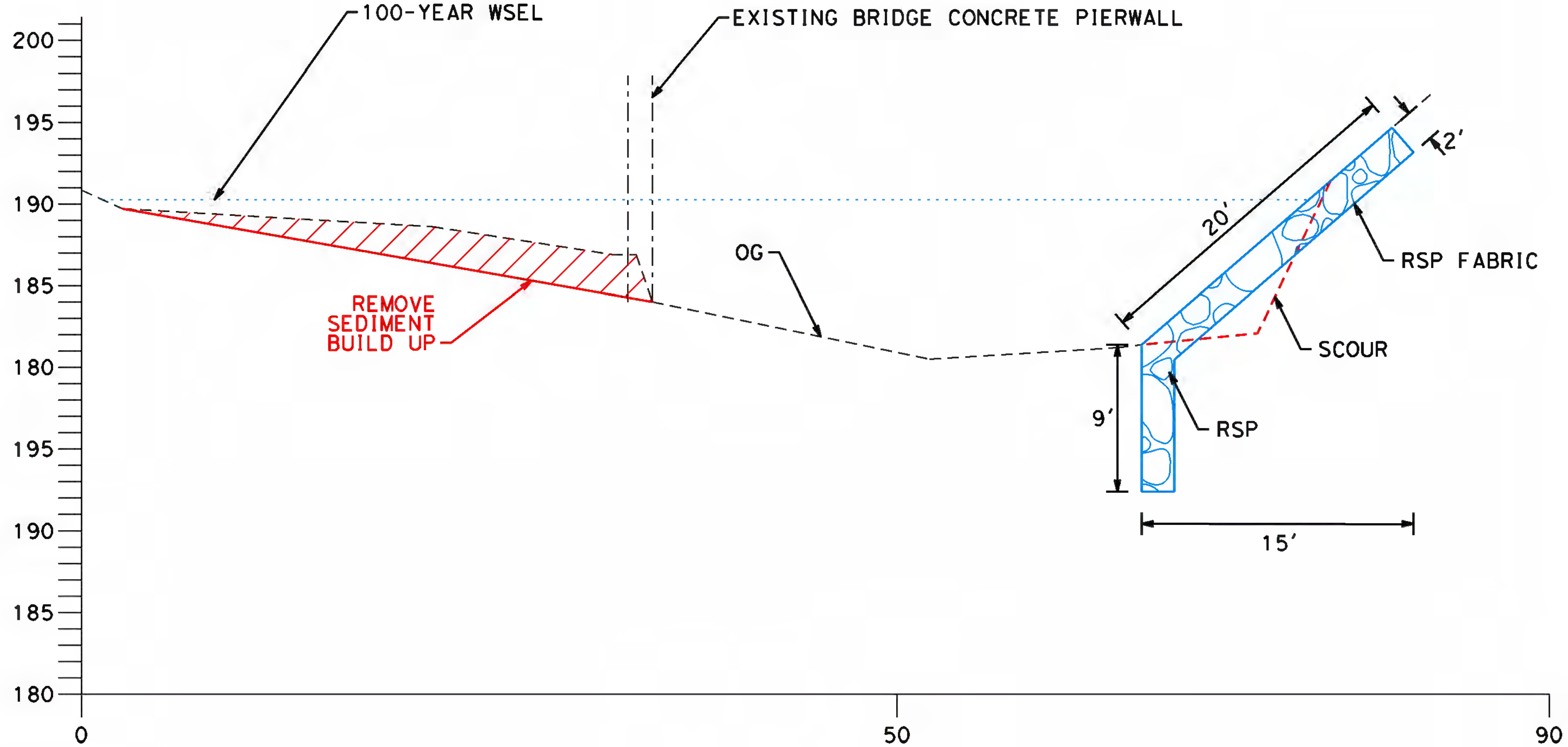
SITE 9 EROSION CONTROL EXHIBIT

BIG CHICO CREEK EROSION REPAIR

NOTE:
1. DURING THE DESIGN PHASE OF THE PROJECT THE CROSS-SECTIONS SHOULD BE FIELD SURVEYED FOR ACCURATE CONFIGURATION.



PLAN
SCALE: 1"=20'



SECTION A-A
SCALE: 1"=5'

DOKKEN ENGINEERING
110 BLUE RAVINE ROAD
SUITE 200
FOLSOM, CA 95630 (916) 858-0642

SITE 10 EROSION CONTROL EXHIBIT

BIG CHICO CREEK EROSION REPAIR

APPENDIX F

Preliminary Cost Estimates

Site 1 - Preliminary Cost Estimate

Big Chico Creek Erosion Repair

July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	TRAFFIC CONTROL SYSTEM	LS	1	$ 3,000	$ 3,000
3	JOB SITE MANAGEMENT	LS	1	$ 6,000	$ 6,000
4	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 6,000	$ 6,000
5	TEMPORARY FIBER ROLLS	LF	305	$ 6	$ 1,830
6	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 30,000	$ 30,000
7	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
8	FIBER ROLLS	LF	220	$ 6	$ 1,320
9	HYDROSEED	SQFT	4085	$ 1	$ 4,085
10	GABION	CY	300	$ 800	$ 240,000
11	MOBILIZATION (10%)	LS	1	$ 31,000	$ 31,000
	TOTAL				**$ 340,235**
			Landscape (10%)		**$ 34,024**
			Minor Items (10%)		**$ 34,024**
			Construction Subtotal		**$ 408,282**
			Contingency (30%)		**$ 122,485**

CONSTRUCTION GRAND TOTAL	**$ 530,800**

Site 2 - Preliminary Cost Estimate
Big Chico Creek Erosion Repair
July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	TRAFFIC CONTROL SYSTEM	LS	1	$ 3,000	$ 3,000
3	JOB SITE MANAGEMENT	LS	1	$ 5,000	$ 5,000
4	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 5,000	$ 5,000
5	TEMPORARY FIBER ROLLS	LF	160	$ 6	$ 960
6	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 30,000	$ 30,000
7	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
8	FIBER ROLLS	LF	100	$ 6	$ 600
9	HYDROSEED	SQFT	1080	$ 1	$ 1,080
10	GABION	CY	76	$ 800	$ 60,800
11	MOBILIZATION (10%)	LS	1	$ 12,400	$ 12,400
	TOTAL				**$ 135,840**
			Landscape (10%)		**$ 13,584**
			Minor Items (10%)		**$ 13,584**
			Construction Subtotal		**$ 163,008**
			Contingency (30%)		**$ 48,902**

CONSTRUCTION GRAND TOTAL	**$ 212,000**

Site 3 - Preliminary Cost Estimate
Big Chico Creek Erosion Repair
July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	TRAFFIC CONTROL SYSTEM	LS	1	$ 3,000	$ 3,000
3	JOB SITE MANAGEMENT	LS	1	$ 6,000	$ 6,000
4	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 6,000	$ 6,000
5	TEMPORARY FIBER ROLLS	LF	315	$ 6	$ 1,890
6	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 30,000	$ 30,000
7	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
8	FIBER ROLLS	LF	180	$ 6	$ 1,080
9	HYDROSEED	SQFT	2625	$ 1	$ 2,625
10	GABION	CY	196	$ 800	$ 156,800
11	MOBILIZATION (10%)	LS	1	$ 22,500	$ 22,500
	TOTAL				**$ 246,895**
			Landscape (10%)		**$ 24,690**
			Minor Items (10%)		**$ 24,690**
			Construction Subtotal		**$ 296,274**
			Contingency (30%)		**$ 88,882**

CONSTRUCTION GRAND TOTAL	**$ 385,200**

Site 4 - Preliminary Cost Estimate
Big Chico Creek Erosion Repair
July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	TRAFFIC CONTROL SYSTEM	LS	1	$ 3,000	$ 3,000
3	JOB SITE MANAGEMENT	LS	1	$ 6,000	$ 6,000
4	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 6,000	$ 6,000
5	TEMPORARY FIBER ROLLS	LF	240	$ 6	$ 1,440
6	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 30,000	$ 30,000
7	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
8	FIBER ROLLS	LF	148	$ 6	$ 888
9	HYDROSEED	SQFT	2465	$ 1	$ 2,465
10	GABION	CY	160	$ 800	$ 128,000
11	MOBILIZATION (10%)	LS	1	$ 19,500	$ 19,500
	TOTAL				**$ 214,293**
			Landscape (10%)		**$ 21,429**
			Minor Items (10%)		**$ 21,429**
			Construction Subtotal		**$ 257,152**
			Contingency (30%)		**$ 77,145**

CONSTRUCTION GRAND TOTAL	**$ 334,300**

Site 5 - Preliminary Cost Estimate

Big Chico Creek Erosion Repair

July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	TRAFFIC CONTROL SYSTEM	LS	1	$ 3,000	$ 3,000
3	JOB SITE MANAGEMENT	LS	1	$ 7,000	$ 7,000
4	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 7,000	$ 7,000
5	TEMPORARY FIBER ROLLS	LF	370	$ 6	$ 2,220
6	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 35,000	$ 35,000
7	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
8	FIBER ROLLS	LF	400	$ 6	$ 2,400
9	HYDROSEED	SQFT	3820	$ 1	$ 3,820
10	GABION	CY	252	$ 800	$ 201,600
11	MOBILIZATION (10%)	LS	1	$ 28,000	$ 28,000
	TOTAL				**$ 307,040**
			Landscape (10%)		**$ 30,704**
			Minor Items (10%)		**$ 30,704**
			Construction Subtotal		**$ 368,448**
			Contingency (30%)		**$ 110,534**

CONSTRUCTION GRAND TOTAL	**$ 479,000**

Site 6 - Preliminary Cost Estimate

Big Chico Creek Erosion Repair

July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	JOB SITE MANAGEMENT	LS	1	$ 5,000	$ 5,000
3	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 5,000	$ 5,000
4	TEMPORARY FIBER ROLLS	LF	220	$ 6	$ 1,320
5	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 30,000	$ 30,000
6	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
7	FIBER ROLLS	LF	215	$ 6	$ 1,290
8	HYDROSEED	SQFT	2360	$ 1	$ 2,360
9	CONCRETE BLOCK WALL	SQFT	600	$ 75	$ 45,000
10	MOBILIZATION (10%)	LS	1	$ 10,700	$ 10,700
	TOTAL				**$ 117,670**
			Landscape (10%)		**$ 11,767**
			Minor Items (10%)		**$ 11,767**
			Construction Subtotal		**$ 141,204**
			Contingency (30%)		**$ 42,361**

CONSTRUCTION GRAND TOTAL	**$ 183,600**

Site 7 - Preliminary Cost Estimate

Big Chico Creek Erosion Repair

July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	JOB SITE MANAGEMENT	LS	1	$ 5,000	$ 5,000
3	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 5,000	$ 5,000
4	TEMPORARY FIBER ROLLS	LF	190	$ 6	$ 1,140
5	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 30,000	$ 30,000
6	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
7	FIBER ROLLS	LF	185	$ 6	$ 1,110
8	HYDROSEED	SQFT	2140	$ 1	$ 2,140
9	CONCRETE BLOCK WALL	SQFT	488	$ 75	$ 36,600
10	MOBILIZATION (10%)	LS	1	$ 9,800	$ 9,800
	TOTAL				**$ 107,790**
			Landscape (10%)		**$ 10,779**
			Minor Items (10%)		**$ 10,779**
			Construction Subtotal		**$ 129,348**
			Contingency (30%)		**$ 38,804**

CONSTRUCTION GRAND TOTAL	**$ 168,200**

Site 8 - Preliminary Cost Estimate

Big Chico Creek Erosion Repair

July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	JOB SITE MANAGEMENT	LS	1	$ 6,000	$ 6,000
3	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 6,000	$ 6,000
4	TEMPORARY FIBER ROLLS	LF	315	$ 6	$ 1,890
5	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 30,000	$ 30,000
6	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
7	FIBER ROLLS	LF	305	$ 6	$ 1,830
8	HYDROSEED	SQFT	3000	$ 1	$ 3,000
9	GABION	CY	140	$ 800	$ 112,000
10	MOBILIZATION (10%)	LS	1	$ 17,800	$ 17,800
	TOTAL				**$ 195,520**
			Landscape (10%)		**$ 19,552**
			Minor Items (10%)		**$ 19,552**
			Construction Subtotal		**$ 234,624**
			Contingency (30%)		**$ 70,387**

CONSTRUCTION GRAND TOTAL	**$ 305,100**

Site 9 - Preliminary Cost Estimate
Big Chico Creek Erosion Repair
July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	JOB SITE MANAGEMENT	LS	1	$ 5,000	$ 5,000
3	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 5,000	$ 5,000
4	TEMPORARY FIBER ROLLS	LF	185	$ 6	$ 1,110
5	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 30,000	$ 30,000
6	CLEARING AND GRUBBING	LS	1	$ 15,000	$ 15,000
7	FIBER ROLLS	LF	170	$ 6	$ 1,020
8	HYDROSEED	SQFT	1275	$ 1	$ 1,275
9	GABION	CY	132	$ 800	$ 105,600
10	MOBILIZATION (10%)	LS	1	$ 16,700	$ 16,700
	TOTAL				**$ 182,705**
			Landscape (10%)		**$ 18,271**
			Minor Items (10%)		**$ 18,271**
			Construction Subtotal		**$ 219,246**
			Contingency (30%)		**$ 65,774**

CONSTRUCTION GRAND TOTAL	**$ 285,100**

Site 10 (Warner Street Bridge) - Preliminary Cost Estimate

Big Chico Creek Erosion Repair

July 2022

ITEM NO.	ITEM	UNIT	ESTIMATED QUANTITY	UNIT COST	AMOUNT
1	CONSTRUCTION AREA SIGNS	LS	1	$ 2,000	$ 2,000
2	TRAFFIC CONTROL SYSTEM	LS	1	$ 3,000	$ 3,000
3	JOB SITE MANAGEMENT	LS	1	$ 7,000	$ 7,000
4	PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	LS	1	$ 7,000	$ 7,000
5	TEMPORARY FIBER ROLLS	LF	585	$ 6	$ 3,510
6	TEMPORARY CREEK DIVERSION SYSTEMS	LS	1	$ 40,000	$ 40,000
7	CLEARING AND GRUBBING	LS	1	$ 20,000	$ 20,000
8	CHANNEL EXCAVATION	CY	350	$ 200	$ 70,000
9	FIBER ROLLS	LF	530	$ 6	$ 3,180
10	HYDROSEED	SQFT	9000	$ 1	$ 9,000
11	ROCK SLOPE PROTECTION (150 LB, CLASS III, METHOD B) (CY)	CY	215	$ 450	$ 96,750
12	ROCK SLOPE PROTECTION FABRIC (CLASS 8)	SQYD	645	$ 23	$ 14,835
13	MOBILIZATION (10%)	LS	1	$ 27,200	$ 27,200
	TOTAL				**$ 298,475**
				Landscape (10%)	**$ 29,848**
				Minor Items (10%)	**$ 29,848**
				Construction Subtotal	**$ 358,170**
				Contingency (30%)	**$ 107,451**

CONSTRUCTION GRAND TOTAL	**$ 465,700**

Big Chico Creek Erosion Repair

PRELIMINARY COST ESTIAMTES SUMMARY

July 2022

Item Description	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9	WARNER STREET BRIDGE	ALL SITES
CONSTRUCTION AREA SIGNS	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 20,000
TRAFFIC CONTROL SYSTEM	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000	-	-	-	-	$ 3,000	$ 18,000
JOB SITE MANAGEMENT	$ 6,000	$ 5,000	$ 6,000	$ 6,000	$ 7,000	$ 5,000	$ 5,000	$ 6,000	$ 5,000	$ 7,000	$ 58,000
PREPARE & IMPLEMENT STORM WATER POLLUTION PREVENTION PLAN	$ 6,000	$ 5,000	$ 6,000	$ 6,000	$ 7,000	$ 5,000	$ 5,000	$ 6,000	$ 5,000	$ 7,000	$ 58,000
TEMPORARY FIBER ROLLS	$ 1,830	$ 960	$ 1,890	$ 1,440	$ 2,220	$ 1,320	$ 1,140	$ 1,890	$ 1,110	$ 3,510	$ 17,310
TEMPORARY CREEK DIVERSION SYSTEMS	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 35,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 40,000	$ 315,000.0
CLEARING AND GRUBBING	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 20,000	$ 155,000.0
CHANNEL EXCAVATION	-	-	-	-	-	-	-	-	-	$ 70,000	$ 70,000
FIBER ROLLS	$ 1,320	$ 600	$ 1,080	$ 888	$ 2,400	$ 1,290	$ 1,110	$ 1,830	$ 1,020	$ 3,180	$ 14,718
HYDROSEED	$ 4,085	$ 1,080	$ 2,625	$ 2,465	$ 3,820	$ 2,360	$ 2,140	$ 3,000	$ 1,275	$ 9,000	$ 31,850
CONCRETE BLOCK WALL	-	-	-	-	-	$ 45,000	$ 36,600	-	-	-	$ 81,600
ROCK SLOPE PROTECTION (150 LB, CLASS III, METHOD B) (CY)	-	-	-	-	-	-	-	-	-	$ 96,750	$ 96,750
GABION	$ 240,000	$ 60,800	$ 156,800	$ 128,000	$ 201,600	-	-	$ 112,000	$ 105,600	-	$ 1,004,800
ROCK SLOPE PROTECTION FABRIC (CLASS 8)	-	-	-	-	-	-	-	-	-	$ 14,835	$ 14,835
MOBILIZATION (10%)	$ 31,000	$ 12,400	$ 22,500	$ 19,500	$ 28,000	$ 10,700	$ 9,800	$ 17,800	$ 16,700	$ 27,200	$ 195,600
LANDSCAPE (10%)	$ 34,024	$ 13,584	$ 24,690	$ 21,429	$ 30,704	$ 11,767	$ 10,779	$ 19,552	$ 18,271	$ 29,848	$ 214,646
MINOR ITEMS (10%)	$ 34,024	$ 13,584	$ 24,690	$ 21,429	$ 30,704	$ 11,767	$ 10,779	$ 19,552	$ 18,271	$ 29,848	$ 214,646
CONSTRUCTION SUBTOTAL	$ 408,282	$ 163,008	$ 296,274	$ 257,152	$ 368,448	$ 141,204	$ 129,348	$ 234,624	$ 219,246	$ 358,170	$ 2,575,756
CONTIGENCY (30%)	$ 122,485	$ 48,902	$ 88,882	$ 77,145	$ 110,534	$ 42,361	$ 38,804	$ 70,387	$ 65,774	$ 107,451	$ 772,727
CONSTRUCTION GRAND TOTAL	**$ 530,800**	**$ 212,000**	**$ 385,200**	**$ 334,300**	**$ 479,000**	**$ 183,600**	**$ 168,200**	**$ 305,100**	**$ 285,100**	**$ 465,700**	**$ 3,348,500**

Appendix I – Stormwater Funding Matrix

Prepared by: CASQA

Stormwater Funding Matrix

2018

Summary Matrix Contents

Stormwater Funding Matrix

2018

Funding Category	Applicability	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
Traditional Mechanisms								
1.01 Parcel Taxes	Can fund all or any parts of a stormwater program as stipulated in the ballot question and authorizing ordinance	Usually a 2/3 majority of voters (general taxes require only 50% majority, but can only go to General Fund)	* Flexible and legally stout; * Debt can be issued in most cases; * Most voters are familiar with Parcel Taxes	* Requires voter approval at the 2/3 level; * Must compete with other ballot measures	X	X	X	X
1.02 Other Special Taxes	* Business License Tax; * Vehicle License Fees; * Sales Tax; * Utility Users Tax; * Transit Occupancy Tax	Typically require a 2/3 voter approval	* Most are flexible in how they can be used; * 50% threshold can be used if a general tax;	* 2/3 voter approval is diffucult to attain; * Ballot measure can be expensive; * If a general tax, then stormwater must compete with other General Fund needs; * Must compete with other ballot questions	X	X	X	X
1.03 Property-Related Fees	Establishes Storm Drainage as a separate utility service and can fund all or any parts of a stormwater program	Prop 218 compliance; * Rigorous rate study; * Must define services and service area; * Property owners approval for non-Water, -Sewer, and -Garbage	* Flexible and legally stout; * Debt can be issued in most cases	* Ballot measure required if for a Storm Drain service - usually voted on by property owners (Not registered voters); * Ballot measure requires significant public outreach; * Public not familiar with balloted property-related fees	X	X	X	X
1.04 General Obligation Bonds	Can fund Capital Projects through debt taken on by municipality	* Voter approval at 2/3 level; * Will need Financial Advising Consultant	* Can fund capital projects or programs with debt paid back over time through property taxes; * Typically easier to pass than a parcel tax; * Taxes based on property value, so annual obligation of individual prop owner is vague	Can only be used for capital costs - Cannot be used for O&M or staff costs		X	X	
1.05 Senate Bill 231	Allows for adoption of property-related fees without having to go to ballot	* Cost of Service Analysis * Rate Study * Prop 218 Protest Hearing	Avoids the cost and risk of a ballot measure	* Taxpayers groups vow to sue on grounds of consititution / court provisions * Governing boards will still have political pressure to not raise rates	X	X	X	X
1.06 Regulatory Fees	Fees and charges for performing administrative activities related to GI	Cannot exceed the actual cost of performing activies such as permit issuanc, inspections, on-site mitigation, etc.	* No voter approval is needed; * Usually included in Master Fee Schedule; * Most municipalities already have these in place	Does not pay for capital improvements or O&M	X			
1.07 Developer Impact Fees	Could incorporate fees for mitigating stormwater impacts - Would not relieve developer of NPDES requirements	Must comply with AB 1600 and include a rigorous nexus study	Could help fund projects and programs	* Requires a nexus study, often times by a consultant; * Nexus study must demonstrate connection between development and GI need; * Administration of funds requires resources; * AB 1600 requires 5-year window for programming funds;		X	X	

Stormwater Funding Matrix

2018

Funding Category	Applicability	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
1.08 Re-Alignment	Stormwater services that support groundwater recharge, diversion to wastewater treatment, or trash capture can be incoporated into existing property-related fee structures without need for ballot measure	Prop 218 compliance for realignment to Water, Sewer or Garbage - must demonstrate applicability	* Existing non-balloted fee mechanisms can help pay for stormwater services; * Enhances integration of stormwater into other muncipal activities; * Causes other utilities to recognize the value of stormwater programs	* Limited to activities attributable to other funded revenue centers; * Prop 218 hawks could challenge; * Outside revenue center will need to raise rates to fund GI activity - politically unpopular; * Has not been widely used; * May be unpopular with Water, Sewer and Garbage managers; * Water or sewer may be handled by separate agencies, making realignment impossible	X	X	X	X
1.09 Grants	One-time infusion of funds for qualifying projects from State or other granting authority	* Project concept must conform to grant requirements; * Most grants are competetive with limit funding available	* Grants are outside sources of funding that do not need to be repaid; * Readiness is a plus, so can benefit a project or program that is well developed and possibly designed; * Some State Revolving Fund loans can be converted to grants through forgiveness clauses	* Projects must be tailored to grant requirements, possibly causing scope and schedule creep; * Most grants require matching funds from other sources; * Most grants require commitment to post-project O&M, but do not fund those activities; * Little control over timing - can be difficult to coordinate with other funding sources; * Competitive nature lowers chances of obtaining grant; * Applying for grants can be time-consuming and require outside help from a grant writer; * Grant administration requires significant resources	X	X	X	???
1.10 Loans	Debt instruments can help accelerate project deliver while paying off debt over time	* Must have dedicated revenue stream to pay off debt; * Must have adequate credit rating to secure reasonable interest rates; * Some Bonds require voter approval	* Can leverage a modest revenue stream by borrowing money up front for rapid project delivery while paying off debt over longer periods of time; * Accelerates project delivery and makes coorination with other funding or projects easier	* Must have dedicated revenue stream to service debt; * Some debt mechanisms require voter approval (GO Bonds, Revenue Bonds, EIFD Bonds)	???	X	X	

Stormwater Funding Matrix

2018

Funding Category		Applicability	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
Special Financing Districts									
2.01	Benefit Assessments	Can fund the construction and maintenance of stormwater projects and programs	Prop 218 compliance; * Rigorous Engineer's Report; * Must deduct general benefit from special benefit; * Property owners approval is required through a ballot proceeding (weighted voting); * Works best with new development due to voting requirement	* Flexible and legally stout; * Can fund both construction and maintenance; * Can use bonded indebtedness	* General Benefit must be separated and paid for by other sources; * Votes are weighted by assessment amount, favoring large land owners		X	X	X
2.02	Community Facilities District	Can fund the construction and maintenance of stormwater projects and programs	Requires vote by majority of landowners or 2/3 majority of registered voters	* Usually formed by developer, so only one ballot is cast; * Very flexible - can fund all aspects; * Subsequent annexation is simple; * Tax rate can be tiered to allow for retirement of debt yet continue with O&M; * Annual administration is more streamline than benefit assessments	* Difficult to form in an existing community due to 2/3 majority requirement; * Known as a Mello-Roos tax - which can have a negative connotation		X	X	X
2.03	Business Improvement Districts	Business and property owners tax themselves to build and maintain stormwater improvements	Formed by a municipality through a notice and protest hearing process.	* Flexible and legally stout; * Can fund both construction and maintenance; * Local improvements can generate local support and involvement * Stormwater improvements can also be amenities; * Can enhance sense of ownership and pride in the neighborhood when results are visible	* Cannot use debt financing; * Opposing businesses can disrupt the progress; * Can burden businesses & property owners so they are unwilling to support other funding measures		X	X	X
2.04	Enhanced Infrastructure Financing Districts (EIFD)	Captures property tax increment similar to redevelopment (RDA) for building and maintaining infrastructure	<u>With No Debt</u>: * Establish a Public Finance Authority; * Adopt a Financing Plan; * Resolution(s) from participating agencies <u>With Debt</u>: * All of the above; * Get approval from at least 55% of voters in District	* Can fund many types of projects; * Does not require a vote (unless debt is part of the plan, then a 55% majority is required); * Can include multiple municipalities and special districts, so area can be tailored to needs (e.g. watersheds, high legacy pollutant areas, countywide); * Does not require a blight finding; * Can overlap with former RDA areas; * Works well with master planned community with a single land owner; * Planning costs can be paid for from proceeds (with limitations); * EIFD can go for up to 45 years	* Education districts are not permitted to participate, so revenues would be much less than RDA; * If overlapping a former RDA area, then cannot proceed until RDA is issued a finding of completion from the State; * Stormwater is only a small piece of what an EIFD can do - it may take a back seat to other, larger community concerns; * Some agencies (i.e. special districts) may not agree to their portion of tax increment to be diverted thereby reducing revenue potential	???	X	X	X

Stormwater Funding Matrix

2018

Funding Category	Applicability	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
Alternative Compliance								
3.01 Alternative Compliance	Allows developers who cannot meet on-site LID requirements to build (or pay for) off-site construction of LID elements	Municipality would need to have alternative projects ready - could bedone case-by-case	* Enables higher density development in certain areas (such as TOD and PDA); * Enables LID in public spaces that private developers would not normally participate in; * Funds can be pooled to finance larger or regional projects that can be more effective; * Post-project O&M can be added in the form of a cash payment or other consideration; * Municipality can be flexible in enforcement to allow hybrid compliance;	* Ad hoc negotiation with developers can be challenging * Agency will need to have off-site or regional projects ready to bring to negotiation	X	X	X	X
3.02 In-Lieu Fee Challenges	Allows developers who cannot meet LID requirements to pay into fund that would finance off-site or regional projects	Municipality would need to estimate the costs of mitigation - could be done case-by-case	* Enables higher density development in certain areas (such as TOD and PDA); * Enables LID in public spaces that private developers would not normally participate in; * Funds can be pooled to finance larger or regional projects that can be more effective; * Municipality can be flexible in enforcement to allow hybrid compliance; * Municipality may consider informal fee process, negotiating each individual developer through COA; * Funds can be leveraged for grants or loans	* Case-by-case approach can be difficult; * Developers will try to evade costs; * May need to comply with AB 1600	X	X	X	X

Stormwater Funding Matrix

2018

Funding Category	Applicability	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
3.03 Credit Trading Programs	Creates LID Credit program for developers and others to trade GI responsibilities to others who have better capability to meet LID goals	A municipality (or regional entity) must create credit trading program including: * Definition of LID Credits; * Relative Value of Credits; * Timing of responsibilities; * Eligibility	* Allows developers who cannot meet NPDES or LID requirements to buy credits created by other entities; * Encourages developers or other entities who have greater LID capacity to over-build LID in order to sell credits in future; * Present value of future O&M costs can be incorporated into credit value; * Allows for flexibility to guide LID to areas with greater pollutant loading need; * May save developers money	* Very few Programs (to use as an example) have been implemented - particularly in California; * Credits may need to stay within same watershed; * Overbuilding LID in some areas may not help other areas; * Overbuilding LID can lead to overlapping LID zones; * Unclear if developers are willing to overbuild on speculation of future sale of credits; * Unclear how value of credits would be established; * Unclear if municipality would be credit broker, or if developers can deal directly with each other; * May be difficult to apply credits to public rights of way; * Costing future O&M is difficult		X	X	X
Partnerships								
4.01 Multi-Agency	Encourages partnerships with non-Stormwater agencies to explore GI co-benefits in their work	Examples may include: * Spreading basins for groundwater agencies; * GI project sites on school grounds; * GI on housing authority sites	* Can generate credits for Credit Trading Program; * Expands GI potential and awareness; * Flexible; * Can leverage limited GI funding to greater benefit	* Not cookie-cutter; requires customization; * May be diffucult to find partners	X	X	X	???
4.02 Transportation	Encourages partnerships with transportation agencies to explore GI co-benefits in their work and take advantage of Complete Streets or Green Streets programs	Examples may include: * Permeable pavements; * Roadside rain gardens; * Cisterns	* Most municipalities are also transportation agencies, so internal project coordination more likely; * Can generate credits for Credit Trading Program; * Expands GI potential and awareness; * Can leverage limited GI funding to greater benefit; * Recent increase in Gas Tax may make more room for GI elements	* Not cookie-cutter; requires customization; * May be diffucult to find partners; * Road condition woes prevail, making it difficult to shift funding to GI and other amenity-type elements; * Transportation grants may preclude using funds for GI	X	X	X	???
4.03 Caltrans Mitigation	Caltrans looks for opportunities for off-site mitigation of stormwater impacts of their highways	Local municipalities may enter in a cooperative agreement with Caltrans to build GI as a way for them to mitigate stormwater impacts of their highways	* Caltrans may furnish funding for local or regional projects that help them meet their obligations; * Locals can propose solutions that benefit both Caltrans and the local agencies	* Caltrans cooperative agreements can be cumbersome and bureaucratic; * Projects that work for Caltrans may be difficult to develop		X	X	???

Stormwater Funding Matrix

2018

Funding Category	Applicability	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
4.04 Public-Private ("P3")	Private enterprises can provide overall solutions to GI programs through better access to resources and capital	P3 is primarily a deliver system for projects where debt provides near-term funding and project acceleration	* Bypasses some of the bureaucracy; * Can make existing funding sources work more efficiently; * Draws on private sector expertise and financing; * Debt may be tax-exempt; * Debt accelerates project delivery; * Can include design, build, finance, operate; * Debt is private - may not affect public ageny's debt capacity	* Does not provide additional funding; * Dedicated revenue stream is needed - cash flow is an important element		X	X	X
4.05 Financial Capability Assessment	Can allow an agency to delay compliance with certain NPDES permit requirements	Follow EPA guidelines for application	Allows a qualifying agency to defer compliance with certain Permit compliance requirements	* Not a source funding - only can grant time extenstions to Permit compliance; * Communities must meet several criteria such as poverty rates, income distibutions, bond ratings, etc.				
4.06 Volunteers	Volunteer groups can be a resource for certain stormwater operations and maintenance (O&M) as well as program planning	* To be effictive, volunteers need organization and oversight; * Can be used to supplement paid contractors, or perform entire projects	* "Free" labor; * Some volunteers provide needed expertise; * Increases awareness of stormwater program; * Some non-profit organizations have ready-made volunteer groups that are trained and organized; * Can build public support for dedicated revenue mechanism such as a fee; * Education program for community	* Requires significant staff resources to recruit, organize, train and plan & supervise the work; * Can be unreliable - hard to build schedule and cost forecasts around volunteer work force; * Can create conflict with prevailing wage requirements; * Difficult to incorporate into project construction work		X	???	X

City of Chico

Storm Water Master Plan

Appendix J – Garner - Esplanade Drainage Area

TECHNICAL MEMORANDUM

TO:	Mr. Richard Burgi, PE, City of Chico
FROM:	Mr. Harvey Oslick, PE, CFM, CPSWQ, EnvSP, Wood Rodgers, Inc.
DATE:	October 1, 2025
SUBJECT:	Garner Lane-Esplanade Area Drainage

REGISTERED PROFESSIONAL ENGINEER HARVEY R. OSLICK No. 54466 Exp. 12/31/25 CIVIL STATE OF CALIFORNIA

I. PURPOSE

The purpose of this appendix to the City of Chico (City) Storm Water Master Plan (SWMP) is to document recommended drainage improvements to support the construction of drainage improvements within City limits along Esplanade between State Route 99 (SR 99) and Mud Creek and along Garner Lane. This appendix provides planning information, including an Opinion of Probable Cost (OPC) for two roadway segments that had not been included in the SWMP when it was adopted in January 2025. This appendix will be incorporated into the SWMP as an addendum to it.

A. Existing Storm Drain Systems in the Study Area

The review of the existing conditions was based on topography data that was used in the SWMP, current development plans provided by the City, as well as aerial and street view imagery. The study area is located north of Mud Creek in an area where the topography generally slopes downward from northeast to southwest. The existing storm drain systems include defined drainage courses, existing storm drains, infiltration systems, and significant ditches along SR 99 and Esplanade. Historically, before ditches were added along Esplanade, overland flow would have drained naturally to the southwest. **Figure J-1** (attached) shows the historical flow patterns. Roadway embankments, ditches and culverts have altered historical drainage patterns.

A detailed review of the existing storm drain system was performed and the SWMP Geographic Information System (GIS) has been updated to include system information identified in the Garner-Esplanade Area. Figure 32 in the SWMP has been updated, accordingly. The California Department of Transportation (Caltrans) District 3 culvert database was reviewed as a starting point to collect existing culverts along Esplanade and SR 99. Additional culverts along the ditches were added to the GIS database based on topographic data and aerial imagery. Record drawings, including current development plans, provided some storm drain feature data. GIS attributes reference the development plans that included the storm drain features. It was assumed that existing drop inlets are connected to infiltration systems. It was also assumed that private drainage systems have infiltration systems within commercial and industrial parcels. Runoff that exceeds the capacity of the infiltration systems would follow an overland release path towards the ditches along Esplanade and SR 99.

Figure J-2 (attached) shows the two primary discharge points of the existing drainage system: one to a 36-inch outfall into Mud Creek east of Esplanade, and the other to a ditch south of Ocean Drive that drains to the southwest from a ditch along Esplanade (South Ditch). As shown in Figure J-2, the existing system includes culverts along SR 99 that discharge into a ditch that conveys runoff into Mud Creek through a 36-inch culvert through the levee. **Figure J-3** (attached) shows an area of approximately 322 acres (area in green) that is tributary to the 36-inch culvert. The drainage area delineation was based on the topographic data to illustrate the entire area that would drain to the 36-inch culvert into Mud Creek. However, most of the developed areas within these 322 acres drain to infiltration systems, resulting in significantly less runoff volume reaching Mud Creek than the volume that originates within the watershed. There are three distinct areas that drain to the South Ditch south of Ocean Drive. Figure J-3 shows an area in red draining into an existing 24-inch culvert that conveys runoff to the ditches along Esplanade that connect to the South Ditch. The tributary area of the 24-inch culvert under SR 99 near Esplanade encompasses approximately 243 acres, and which also includes areas with infiltrations systems. A tributary area of approximately 17 acres (brown) drains to a 12-inch culvert that drains along Esplanade to the South Ditch. Lastly, a tributary area of approximately 26 acres (yellow) drains to a 6.75-foot by 2.0-foot box culvert and discharges across Esplanade just north of the South Ditch.

Figure J-1 shows a blue line stream that crosses SR 99 just north of the City's Sphere of Influence at the location of a 3-foot-high by 6-foot-wide box culvert. The analysis presented in this technical memorandum did not evaluate the potential for flows draining towards this culvert to reach the area of concern along Esplanade because the impacts of grade changes outside of the City's sphere of influence were not evaluated as part of the SWMP. Field grading and berms may deflect runoff that had historically drained to the west past this box culvert towards the south where it may contribute to flooding south of Esplanade.

B. Existing Conditions Capacity and Flow Rates

The key parameters evaluated to provide a basis for planning-level recommendations were the capacities of existing culverts, the estimated runoff flow rates from the identified drainage areas, and the capacities of the ditches along Esplanade. The flow capacities of the critical drainage features were evaluated using a simplified method that considered feature dimensions and hydraulic grade line constraints rather than the comprehensive modeling that was used in the rest of the SWMP. This method provides a reasonable estimate for the capacities of the key culverts and ditches.

There were five drainage features that were evaluated:

- The capacity of the 24-inch culvert under SR 99 north of Esplanade was computed to be 19 cubic feet per second (cfs). The ditch downstream plays a critical role in determining the flow capacity of the culvert. An iterative method was used to calculate the flow rate using the Bently FlowMaster computer program.
- The capacity of the 36-inch culvert that discharges into Mud Creek was evaluated using the tailwater elevation from the SWMP HEC-RAS Model. The results were extracted for the 10-year storm to establish a water level at the discharge point of the 36-inch culvert of 173 feet.

The allowable water level at the upstream end of the 36-inch culvert is estimated to be 176 feet, resulting in an estimated capacity of 45 cfs.

- The 6.75-foot by 2.0-foot box culvert under Esplanade north of the South Ditch has an estimated capacity of 21 cfs (using a similar approach to that used to estimate the capacity of the 24-inch culvert).
- The 12-inch culvert along Esplanade near SR 99 has an estimated capacity of 4 cfs.
- The available topographic data was used to evaluate the capacity of the ditch along the west side of Esplanade flowing towards the South Ditch. There is significant uncertainty regarding the capacity of the ditch due to vegetation that may impact the accuracy of the terrain. It is estimated that the capacity of the ditch is less than 20 cfs and may be significantly less than that at the point where flows would spill out of the ditch to the west and flow across private property in the vicinity of Ocean Drive.

Existing drainage areas were delineated using LiDAR topographic data. Nine watersheds were delineated for the Study Area. That Rational Method was used to calculate peak 2-year and 10-year flow rates for the existing conditions. **Table 1** (below) shows the key parameters that were used. The runoff coefficient values were estimated using the 2018 aerial imagery, the General Plan Land Use data and the Runoff Coefficient listed in Table 3 of the SWMP. Areas that included developed commercial or industrial parcels that drain to infiltration systems were removed from the calculations because it was assumed that no runoff[1] would be generated from those areas in these design storms. The residential lots average two houses per acre, which is typical of rural residentials for which the C-value would be 0.35. Undeveloped areas were assigned a C-value of 0.25. The roadway areas were assigned a C-value of 0.9. The average rainfall intensity was computed for a duration equal to the time of concentration. The intensity calculator spreadsheet provided with the SWMP was used to compute the rainfall intensity based on time of concentration, precipitation zone, and recurrence interval. The time of concentration was determined using a procedure described in the U.S. Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) Conservation Engineering Division's "*TR-55, Urban Hydrology for Small Watersheds*" (June 1986).

[1] Section 10.10-2 of the Butte County Public Works Improvement Standards state that infiltration trenches "shall be designed to contain a one in ten year frequency storm." Therefore, it is reasonable to assume that there would be no runoff from the parcels that were developed with on-site drainage systems during the 2-year and 10-year storms.

Table 1: Watershed Peak Flow Parameters							
Name	**Total Watershed Area (acres)**	**Watershed Area w/o Infiltration Systems (acres)**	**Runoff Coeffiecient**	**2-Year Intensity (in/hr)**	**10-Year Intensity (in/hr)**	**2-Year Peak Flow (cfs)**	**10-Year Peak Flow (cfs)**
WS_A	91	91	0.35	0.553	0.808	18	26
WS_B	46	31	0.37	0.633	0.923	7	11
WS_C	106	77	0.39	0.565	0.825	17	25
WS_D	11	11	0.30	0.948	1.385	3	5
WS_E	17	8	0.66	0.758	1.105	4	6
WS_F	26	11	0.25	0.822	1.199	2	3
WS_G	38	20	0.38	0.803	1.171	6	9
WS_H	26	26	0.50	0.681	0.993	9	13
WS_ABC	199	243	0.37	0.463	0.68	34	50
WS_DGH	57	75	0.42	0.63	0.92	15	22
Potential Source	247	-	0.35	0.299	0.446	-	-

Based on these calculations and estimates, the capacity of the existing 24-inch culvert appears to be inadequate for the 2-year and 10-year storms (Combined Watersheds A, B, and C). The existing conditions peak flow of the tributary drainage area WS_ABC is approximately 34 cfs and 50 cfs for the 2-year storm and 10-year storm, respectively. The estimated capacity of the culvert is 19 cfs under head limited flow. However, no flooding issues have been reported by the City in this area, suggesting that actual flow rates may be lower than estimated. The calculations indicate that the 36-inch culvert discharging into Mud Creek has enough capacity to accommodate peak flows for the 2-year and 10-year storms from the combination of Watersheds D, G, and H. The combined peak flow of WS_DGH is approximately 15 cfs for the 2-year storm and 22 cfs for the 10-year storm; however, this excludes runoff from the watershed labeled “Potential Source.” The “Potential Source” watershed was excluded because it includes street drainage inlets that are assumed to manage runoff up to at least a 10-year storm before any overland release towards the Caltrans right-of-way would occur. The 6.75-foot by 2-foot box culvert located along Esplanade has sufficient capacity to convey peak flows for both the 2-year and 10-year storms (Watershed F). The tributary drainage area produces a peak flow of 2 and 3 cfs for the 2-year and 10-year storms, respectively. The 12-inch culvert has an estimated capacity of approximately 4 cfs. Calculations indicate that this capacity is sufficient to convey peak flows from the 2-year storm event, but is inadequate for the 10-year event (Watershed E).

II. MASTERPLAN IMPROVEMENTS

The proposed drainage improvements along Esplanade are recommended to convey roadway runoff into Mud Creek without increasing the risk of flooding near Three Sevens Lane while also reducing discharges into the South Ditch. The concept-level master-planned facilities for the Project area include a gravity storm drain system along Esplanade extending from a location near SR 99 to a new outfall at Mud Creek. This planning-level investigation is based on the installation of storm drain pipes. Alternatively, ditch improvements with equivalent capacities may be implemented for some parts of it, if it is determined to be feasible during design-level investigations. (The ditch alternative will require detailed consideration of the hydraulic grade line, controlling ground elevations, ditch geometries, and right-of-way requirements. The pipe option could be constructed generally within the existing right-of-way.) The master planned system includes a surcharge release into the South Ditch. The proposed system would convey flows of up to approximately the capacity of the 24-inch culvert that receives runoff from WS_ABC plus some added flow along Esplanade, although a much larger pipe (36-inch) would be required due to the flatness of the hydraulic grade line. The proposed system would reduce the discharges to the South Ditch by including conveyance equivalent to the capacity of the 24-inch culvert all the way to Mud Creek. Additionally, a new gravity storm drain will be added along Garner Lane and Esplanade, connecting to the ditch that leads to the existing 36-inch-diameter outfall into Mud Creek. The placement of these drainage features was determined based on site-specific conditions and in accordance with the City of Chico's Code of Ordinances. Drop inlets are located at low points along the roadway and are spaced no more than 500 feet apart to ensure effective stormwater collection. Standard catch basins would be used where curb and gutter would be constructed, and field inlets would be used elsewhere.

The proposed drainage system was not sized for a specific design storm. Rather, it was sized to provide substantial improvement over existing conditions. There is significant uncertainty in what the standard design storm (10-year storm) discharge rate is at key locations. The analysis presented herein indicates that the 24-culvert that receives runoff from WS_ABC has less capacity than the 2-year storm. However, this was not identified as a known drainage efficiency. It would be possible to perform complex analyses of conditions that might cause SR 99 to be overtopped (there is a low point approximately 700 feet north of the 24-inch culvert) and to evaluate drainage conditions associated with the 3-foot-high by 6-foot-wide box culvert north of the City's sphere of influence. However, the results would still have significant uncertainty associated due to limitations of the available topographic data and hydrologic uncertainty. Rather than perform complex analyses, the recommended improvements are intended to convey runoff discharged from the 24-inch culvert to Mud Creek, diverting it from the South Ditch, in order to accommodate local drainage improvements along Esplanade and provide a net improvement in the vicinity of Ocean Drive.

The master planned solution includes a 42-inch-diameter storm drain that would connect to the existing 24-inch-diameter culvert beneath SR 99. A pipe inlet would be needed to intercept any upstream ditch drainage that is within the capacity of the new system

The SWMP shows the 42-inch storm drain transitioning into a 48-inch storm drain that connects to a box junction structure. This structure would include a surcharge release system that would consist of a weir within the box. The 48-inch segment of the storm drain would convey up to approximately 30 cfs and would collect runoff from Watersheds E and F.

Downstream from the box junction, the SWMP calls for a 36-inch storm drain to convey the combined flow and discharge through a new 36-outfall into Mud Creek. The 36-inch storm drain would have an estimated capacity of 20 cfs. Any flow exceeding this capacity would be diverted through the surcharge system into the South Ditch. The final configuration of the surcharge release pipe will be determined during the detailed design phase.

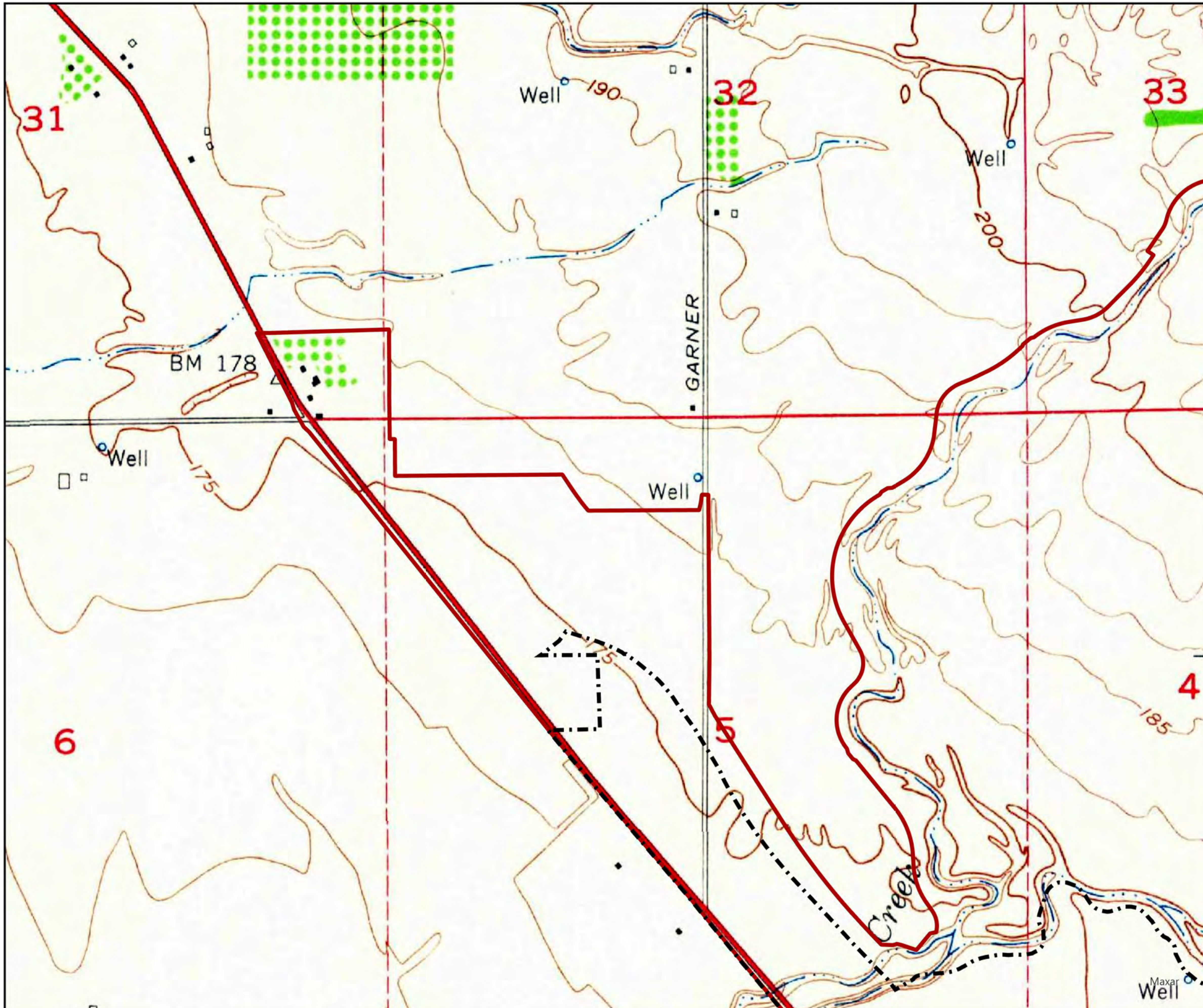
City ordinances for storm drainage (15.04.020 and 18R.08.050 Part J) call for infiltration leach fields to be used to contain a one-in-ten year frequency storm when development projects are constructed before City storm drainage systems. Due to the unique conditions and constraints in the area that drains to Esplanade and Garner Lane that make it infeasible for the City to construct a drainage system to fully comply with City drainage design criteria, projects will continue to be required to incorporate infiltration systems designed to contain a one-in-ten year frequency storm even after a new storm drain along Esplanade has been constructed. Retention volume below any gravity drain elevation that is provided within systems designed to comply with the Post-Construction Standards Plan can be counted towards to volume to contain a one-in-ten year frequency storm.

III. OPINIONS OF PROBABLE COST

Table 2 (below) shows the estimated costs for the master planned improvement illustrated in Figure 32 in the SWMP based on unit costs presented in the final SWMP. The costs are considered planning-level Opinions of Probable Costs (OPCs) using 2024 dollars consistent with those tabulated in the SWMP. Other costs are included in the planning-level cost estimates as percentages of constructions costs. A fifty-percent factor was applied to the construction base cost to account for other miscellaneous Project costs as explained in the SWMP.

Table 2: Opinions of Probable Costs

Item No.	Item Description	Unit	Unit Cost	Quantity	Base Construction Cost	Other Costs	Total Cost
1	12″ Dia. Pipe	L.F	$155	360	$55,800	$27,900	$83,700
2	15″ Dia. Pipe	L.F	$189	1,540	$291,060	$145,530	$436,590
3	24″ Dia. Pipe	L.F	$297	55	$16,306	$8,153	$24,459
4	36″ Dia. Pipe	L.F	$465	2,460	$1,143,900	$571,950	$1,715,850
5	42″ Dia. Pipe	L.F	$559	617	$344,903	$172,452	$517,355
6	48″ Dia. Pipe	L.F	$659	1,718	$1,132,221	$566,110	$1,698,331
7	New Catch Basin/Field Inlet	Ea.	$5,000	20	$100,000	$50,000	$150,000
8	15″ Outfall	Ea.	$16,000	1	$16,000	$8,000	$24,000
9	24″ Outfall	Ea.	$30,000	1	$30,000	$15,000	$45,000
10	36″ Outfall	Ea.	$42,000	1	$42,000	$21,000	$63,000
11	48″ Manhole	Ea.	$12,500	2	$25,000	$12,5000	$37,5000
12	60″ Manhole	Ea.	$16,000	7	$112,000	$56,000	$168,000
13	72″ Manhole	Ea.	$21,000	2	$42,000	$21,000	$63,000
14	Box Junction	Ea.	$50,000	1	$50,000	$25,000	$75,000
15	Manhole with Flap Gate	Ea.	$30,000	1	$30,000	$15,000	$45,000
16	Pipe Inlet	Ea.	$12,500	1	$12,500	$6,250	$18,750
	TOTAL				**$3,443,689**	**$1,721,845**	**$5,165,534**



USGS HISTORICAL MAP (1951)

CITY OF CHICO
JULY 2025

NORTH

0 400 800
Feet

Legend

City Limits
Sphere of Influence

WOOD RODGERS

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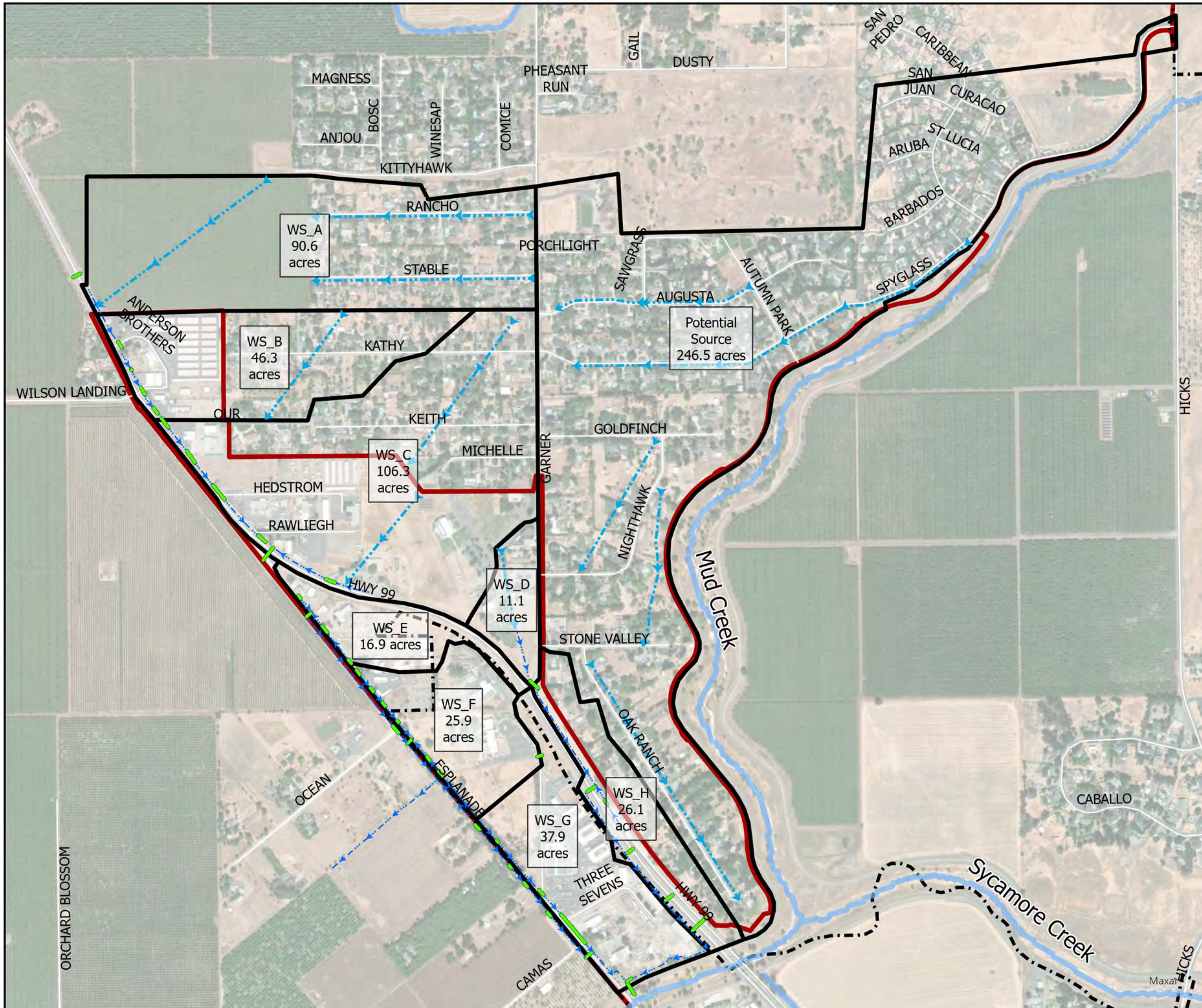
FIGURE J-1



GARNER LANE AND ESPLANADE DRAINAGE AREA

CITY OF CHICO
JULY 2025

NORTH

0 400 800
Feet

Legend

- Flow Line
- Overland Flow Direction
- Stream
- Culvert
- City Limits
- Sphere of Influence
- Drainage Area

WOOD RODGERS

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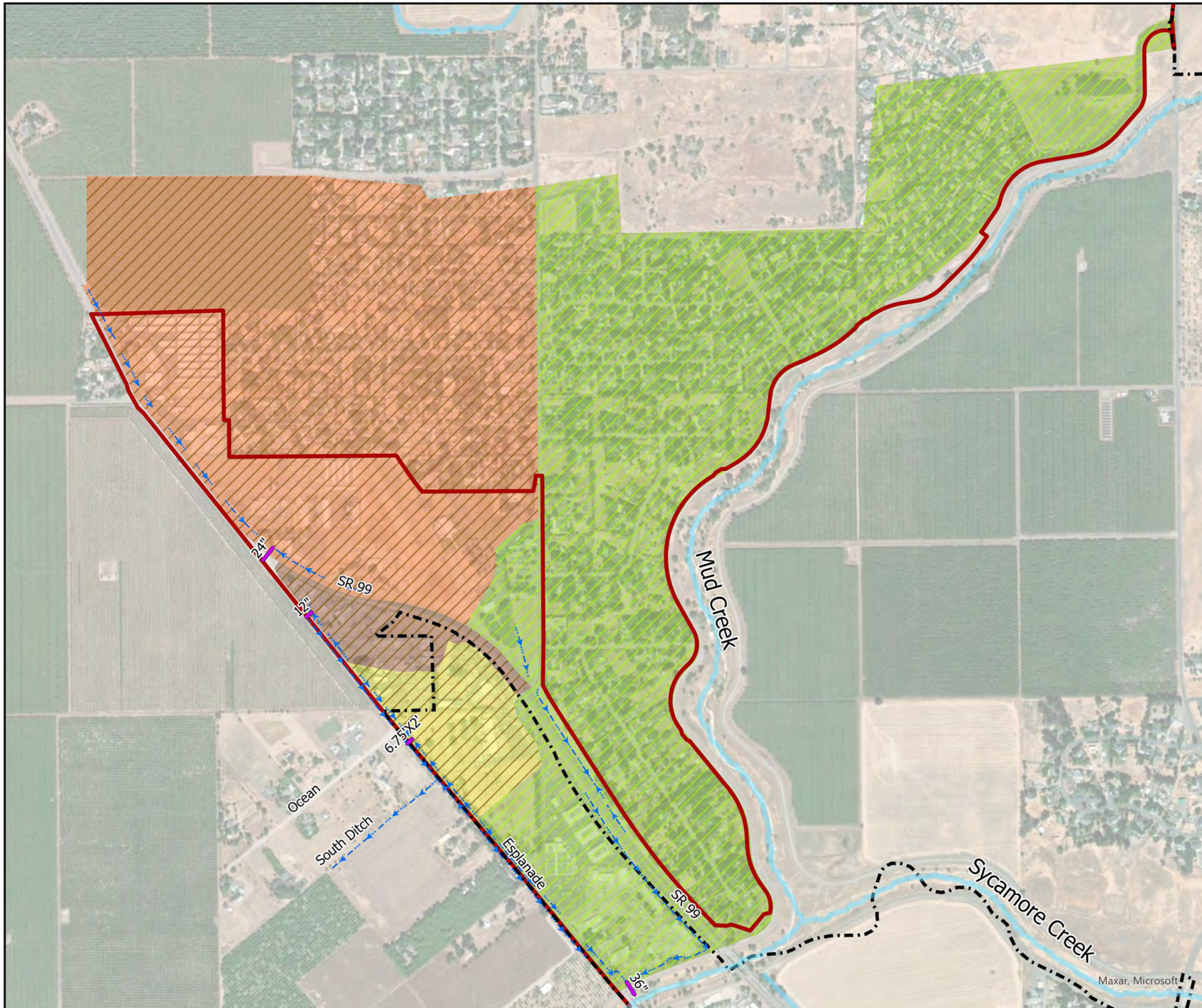

EXISTING TRIBUTARY AREA TO MAJOR STORM DRAIN FEATURES

CITY OF CHICO
JULY 2025

NORTH

0 400 800
Feet

Legend

- Flow Line
- Culvert
- Stream
- Tributary Area to 24-Inch Culvert
- Tributary Area to 36-Inch Culvert
- Tributary Area to 6.75'W X 2'H Box Culvert
- Tributary Area to 12-Inch Culvert
- Sphere of Influence
- Mud Creek Tributary Area
- South Ditch Tributary Area
- City Limits

NOTES:

Drainage areas were delineated based on topographic data. Most of these areas drain runoff to infiltration systems. When runoff exceeds the capacity of these infiltration systems, the excess flow is conveyed to existing storm drain structures.

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